INRS
Université d'avant-garde

Centre - Eau Terre Environnement

Annual Report 2009-2010

Annual Report from 1 June 2009 to 31 May 2010
Available in electronic format at **www.ete.inrs.ca/ete/publications**

Compilation
Mathilde Renaud

Language Revision
Bill Robinson

Graphic Design
France Lévesque communication

Cover Page Photo
Antoine Nicault

Photo Credits
Jessy Barrette, Paschale Noël Bégin, Yves Bégin, Jean-Daniel Bourgault, Satinder Kaur Brar, Peter G.C. Campbell, Clément Clerc, Arnaud De Coninck, Pierre Francus, Carole-Anne Gillis, Elsa Goerig, Lyal Harris, Pierre Lafrance, René Lefebvre, Isabelle Laurion, Joëlle Marion, MDA and Canadian Space Agency, Pierre-Simon Ross, Alain N. Rousseau, Jean-Michel Thériault, André Tessier.

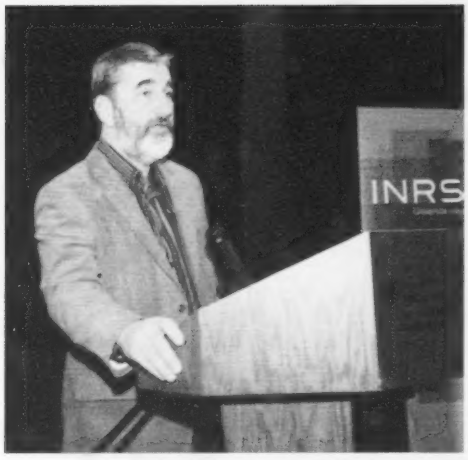
Contact Information

Institut national de la recherche scientifique
Centre - Eau Terre Environnement
490, de la Couronne
Québec (Québec) G1K 9A9
CANADA
Phone: 418 654-2524
Fax: 418 654-2600
Email: info@ete.inrs.ca
Web site: www.ete.inrs.ca

© INRS, Centre - Eau Terre Environnement, 2011
Legal Deposit, Bibliothèque nationale du Québec
Legal Deposit Library and Archives Canada

Director's message

2009-2010



I am pleased to present the 9th annual report of the Centre Eau Terre Environnement of the Institut national de la recherche scientifique for the year 2009-2010.

The mission of the Centre is to contribute to sustainable development and environmental improvement, particularly in the fields of water and earth sciences. Graduate training, diffusion of knowledge, and technology transfer are all essential elements of this mission.

This report highlights the most important projects of the year. Examples include projects on groundwater characterization in Montérégie, soil contamination by energetic materials on Canadian military bases, degradation of water lines in Quebec City, management of rain water in urban areas in the context of climate change, impacts of climate change on aspects of human health, natural gas exploration using geophysical methods, and monitoring of fish in rivers using telemetry; all of these projects originated in ideas and initiatives of the Centre's dynamic group of researchers.

Professors at the Centre have had several successes this year in financing research infrastructure. Two new laboratories were set up with the financial support of the Leaders Opportunity Fund of the Canadian Foundation for Innovation. The Centre also obtained financing from the Knowledge Infrastructure Program of the governments of Canada and Quebec to build a large hydraulic channel. Lastly, the INRS contributed to the creation of a research station at Radisson in the James Bay region as part of a Canadian government program for northern infrastructure; the Centre's professors who are members of the Centre d'études nordiques obtained important financing through this program. In total, these new investments amounted to 18 million dollars.

The graduate programs in earth sciences have been evaluated and renewed. These programs are operated in collaboration with the Université Laval. At the INRS fall convocation ceremony, 20 PhD students and 27 Master's students from the Centre received a diploma.

In February, the launch of the book *INRS-Eau, 30 ans d'histoire* was an important event. This work reports on the scientific adventure experienced by the pioneering researchers and those who followed at one of the first research centres of the INRS.

This report thus highlights the main achievements of the Centre Eau Terre Environnement during 2009-2010. Credit for those achievements belongs to the Centre's community, including the professors, students and fellows, the associate professors and researchers, in particular those of the Geological Survey of Canada with whom we share our offices, and our entire staff.

I sincerely thank them all.

The Director,
Yves Bégin

INRS
Université d'avant-garde

Centre - Eau Terre Environnement

Institut national de la recherche scientifique

The mission of the INRS (Quebec's national institute of scientific research) is to conduct pure and applied research for the social, economic, and cultural benefit of Quebec. This university research institution seeks to train highly qualified professionals at the graduate level and ensure the transfer of knowledge and technologies in its areas of expertise. The INRS offers to its students and professors an innovative research environment focused on society's needs.

The INRS is composed of four research centres:

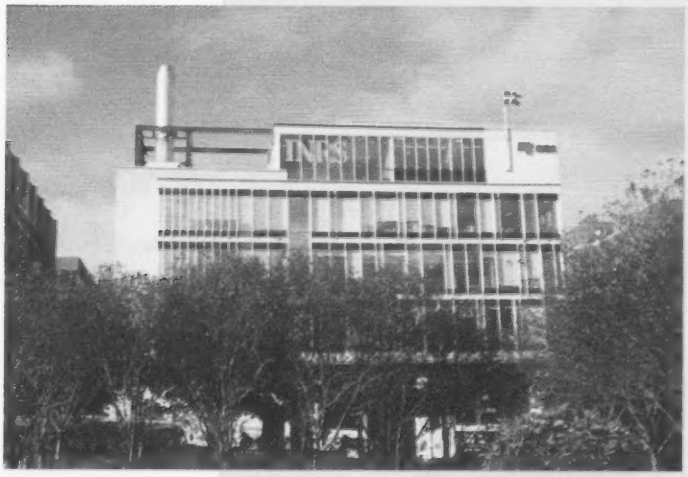
- Eau Terre Environnement
  (research centre on water, earth, and the environment)
- Énergie Matériaux Télécommunications
  (research centre on energy, materials, and telecommunications)
- INRS-Institut Armand-Frappier (health research centre)
- Urbanisation Culture Société
  (research centre on urbanization, culture, and society)

Centre Eau Terre Environnement

The Centre is actively engaged in the sustainable development of Quebec, particularly in the fields of water science, georesources, and the environment. Its research is at the forefront of scientific and technological advances, facilitating the protection and sustainable development of natural resources. The Centre offers graduate programs (PhD, research and professional Master's) in water and earth sciences. Internships are also available at all university levels.

The scientific program is divided into four main research fields: hydrology, biogeochemistry and contamination issues, geological sciences, and environmental decontamination and waste reclamation.

The Centre is located in downtown Quebec City within the urban campus of the Université du Québec. Its large-scale laboratories are located at the Metropolitan Quebec Technology Park, and it has an environmental research station at Sacré-Coeur, in the Saguenay region.



Contact Information

Institut national de la recherche scientifique
Centre - Eau Terre Environnement
490, de la Couronne
Québec (Québec) G1K 9A9
CANADA
Phone: 418 654-2524
Fax: 418 654-2600
Email: info@ete.inrs.ca
Web site: www.ete.inrs.ca

INRS
Université d'avant-garde

Hydrology
2009-2010

Centre - Eau Terre Environnement

Canada possesses a considerable share of the world's fresh water.

Sustainable management of this vital resource is a priority research subject at the Centre Eau Terre Environnement, which hosts the most important group of university experts in water research in Canada.

The Centre's expertise derives from its long experience in developing and applying numerical approaches to analysis and decision-making in a range of water management contexts. The tools developed are based on numerical hydrology, geomatics, and remote sensing. The group's multidisciplinarity allows thorough analysis of both resource availability and associated environmental problems. A central theme of the Centre's hydrology research is the impact of and adaptation to climate change.

Examples of research applied to current challenges

Fish swimming underneath our roads

Quebec's highway network contains thousands of road culverts. These culverts are intended to enable unimpeded movement of water and fish, but our capacity to model their performance is limited. This project's objective is to study the capacity of brook trout to pass through different types of road culverts. PIT-tag (Passive Integrated Transponder) technology is used to follow the fish. This technology enables continuous monitoring of marked-fish movements using antennas placed inside the culverts. These data will be used to model fish passage success under Quebec's roads.

Drinking water, a management issue

Integrated watershed-based water management is one of the main commitments of Quebec's National Water Policy. Quebec City has also taken steps in this direction. The city is implementing the GIBSI (*Gestion Intégrée des Bassins versants à l'aide d'un Système Informatisé*) model developed at the INRS. This research project also includes a study of the contamination risks at the water intake in the Saint-Charles River where the city draws half of its drinking water. The objective is to determine how long it takes for contaminated water to reach the intake site and how quickly we need to react in order to protect the water supply.

Statistical hydrology helps engineers

Canada is the 2nd most important hydroelectricity producer in the world. It possesses a very large number of hydraulic works. Designing such a structure requires good knowledge of the river's hydrological regime. Having good estimates of the river's flow is essential in order to correctly dimension the work and to ensure sufficient minimal flow for protecting the habitats of aquatic species. Statistical models are thus being developed to assist engineers in the design of hydroelectric works.

Main study themes and researchers involved

WATERSHED HYDROLOGY

Monique Bernier | Remote sensing
monique.bernier@ete.inrs.ca

Karem Chokmani | Remote sensing
karem.chokmani@ete.inrs.ca

Alain N. Rousseau | Modeling and management
alain.rousseau@ete.inrs.ca

Jean-Pierre Villeneuve | Integrated management
jean-pierre.villeneuve@ete.inrs.ca

ENVIRONMENTAL HYDRAULICS

Normand E. Bergeron | Fluvial geomorphology
normand.bergeron@ete.inrs.ca

Yves Secretan | Numerical hydrology
yves.secretan@ete.inrs.ca

URBAN HYDROLOGY

Sophie Duchesne | Modeling and management
sophie.duchesne@ete.inrs.ca

Alain Mailhot | Modeling and management
alain.mailhot@ete.inrs.ca

Jean-Pierre Villeneuve | Integrated management

STATISTICAL HYDROLOGY

Fateh Chebana | Hydrological modeling
fateh.chebana@ete.inrs.ca

Taha B.M.J. Ouarda | Hydrometeorological modeling | taha.ouarda@ete.inrs.ca

André Saint-Hilaire | Aquatic habitats
andre.st-hilaire@ete.inrs.ca

Examples of recent publications

(INRS-ETE authors are in **bold**)

- **Chebana**, **Fateh** & **Taha B.M.J. Ouarda** (2009). Index flood-based multivariate regional frequency analysis. *Water Resources Research*, 45: W10435. DOI: 10.1029/2008WR007490

- Dridi, L., **Alain Mailhot**, M. Parizeau & **Jean-Pierre Villeneuve** (2009). Multiobjective approach for pipe replacement based on Bayesian inference of break model parameters. *Journal of Water Resources Planning and Management*, 135(5): 344–354. DOI: 10.1061/(ASCE)0733-9496(2009)135:5(344)

- Gherboudj, I., **Monique Bernier** & R. Leconte (2010). A backscatter modeling for river ice: Analysis and numerical results. *IEEE Transactions on Geoscience and Remote Sensing*, 48(4): 1788–1798. DOI: 10.1109/TGRS.2009.2034256

- **Johnston**, **Patricia** & **Normand E. Bergeron** (2010). Variation of juvenile Atlantic salmon (*Salmo salar*) body composition along sedimentary links. *Ecology of Freshwater Fish*, 19(2): 187–196. DOI: 10.1111/j.1600-0633.2009.00403.x

- Kamali Nezhad, M., **Karem Chokmani**, **Taha B.M.J. Ouarda**, M. Barbet & P. Bruneau (2010). Regional flood frequency analysis using residual kriging in physiographical space. *Hydrological Processes*, 24(15): 2045–2055. DOI: 10.1002/hyp.7631

- **Khalil**, **Bahaa**, **Taha B.M.J. Ouarda**, **André St-Hilaire** & **Fateh Chebana** (2010). A statistical approach for the rationalization of water quality indicators in surface water quality monitoring networks. *Journal of Hydrology*, 386: 173–185. DOI: 10.1016/j.jhydrol.2010.03.019

- **Savary**, **Stéphane**, **Alain N. Rousseau** & **Renaud Quilbé** (2009). Assessing the effects of historical land cover changes on runoff and low flows using remote sensing and hydrological modeling. *Journal of Hydrologic Engineering*, 14(6): 575–587. DOI: 10.1061/(ASCE)HE.1943-5584.0000024

- Terrado, M., **Martin-Pierre Lavigne**, **Sébastien Tremblay**, **Sophie Duchesne**, **Jean-Pierre Villeneuve**, **Alain N. Rousseau**, D. Barceló & R. Tauler (2009). Distribution and assessment of surface water contamination by application of chemometric and deterministic models. *Journal of Hydrology*, 369(3-4): 416–426. DOI: 10.1016/j.jhydrol.2009.02.030

Some research partners

- AXA Insurance
- Ouranos Consortium on Regional Climatology and Adaptation to Climate Change
- Government of Canada (Environment, Indian and Northern Affairs)
- Government of Quebec (Economic Development, Innovation and Export Trade; Health and Social Services; Transport)
- Hydro-Québec
- Quebec City

INRS
Université d'avant-garde

Centre Eau Terre Environnement
Institut national de la recherche scientifique
490 de la Couronne | Québec (QC) Canada | G1K 9A9
418.654.2524 | info@ete.inrs.ca | www.ete.inrs.ca

INRS
Université d'avant-garde

Biogeochemistry
2009-2010

Centre - Eau Terre Environnement

Water pollution is one of the main environmental problems confronting society.

Pollutants enter aquatic ecosystems from point (e.g., spills) and diffuse (e.g., agriculture) sources, accumulate in sediments, and concentrate up the food chain. A good knowledge of the processes controlling the exchange of toxic substances between sediments, the water column, and aquatic organisms, and of the effects of these substances on ecosystems, is essential in order to remediate the problem.

The Centre Eau Terre Environnement biogeochemistry research group makes a unique contribution to remediation efforts through its capacity to combine research on contaminant dispersion in the environment, the assimilation of and effects of trace metals on aquatic organisms, and the detection of environmental changes in aquatic ecosystems by using certain organisms as sentinels.

Examples of research applied to current challenges

Algae as measurement tools

Metal contamination of aquatic environments is a major environmental concern in mining regions. The toxicological risks for aquatic organisms depend on the metal's bioavailability (i.e., the quantity of metal that can be absorbed by a living organism). The researchers are using the biological responses of "test" algae in contaminated water to develop predictive models for metals' bioavailability in aquatic environments. The idea is that prediction should permit prevention.

Mercury travels far north

Mercury is a neurotoxic contaminant that accumulates up the food chain and poses threats to human health. Atmospheric mercury can be transported very long distances, even reaching the Canadian Arctic, where it is accumulating. This metal has a complex chemistry. A Quebec–USA research team studies the biogeochemical cycle of mercury in the air, snow, and water near northern communities with the aim of identifying the zones with the highest risks of contamination for animals and the population that eats them.

More BMPs to improve water quality

Agricultural Best Management Practices (BMPs) are intended to minimize environmental risks, such as risks to surface water quality. The Bras Henri watershed near Quebec City is part of an evaluation of watershed BMPs carried out by Agriculture and Agri-Food Canada. One of the objectives is to examine the effectiveness of BMPs such as vegetative riparian strips and grassed waterways in reducing herbicide transfer to surface water.

Main study themes and researchers involved

ENVIRONMENTAL GEOCHEMISTRY

Charles Gobeil | Aquatic contamination
charles.gobeil@ete.inrs.ca

Pierre Lafrance | Organic contaminants
pierre.lafrance@ete.inrs.ca

AQUATIC ECOTOXICOLOGY

Peter G.C. Campbell | Metal contaminants
pgc.campbell@ete.inrs.ca

Patrice Couture | Fish biology
patrice.couture@ete.inrs.ca

Paul Drevnick | Mercury contamination
paul.drevnick@ete.inrs.ca

Claude Fortin | Metal contaminants
claude.fortin@ete.inrs.ca

Landis Hare | Freshwater invertebrates
landis.hare@ete.inrs.ca

LIMNOLOGY

Jean-Christian Auclair | Plankton limnobiology
jean-christian.auclair@ete.inrs.ca

Isabelle Laurion | Microbial ecology
isabelle.laurion@ete.inrs.ca

OCEANOGRAPHY

Yves Gratton | Physical processes
yves.gratton@ete.inrs.ca

Examples of recent publications

(INRS-ETE authors are in **bold**)

- **Breton, Julie, Catherine Vallières** & **Isabelle Laurion** (2009). Limnological properties of permafrost thaw ponds in northeastern Canada. *Canadian Journal of Fisheries and Aquatic Sciences*, 66(10): 1635–1648. DOI: 10.1139/F09-108

- **Caron, Emmanuelle, Pierre Lafrance, Jean-Christian Auclair** & M. Duchemin (2010). Impact of grass and grass with poplar buffer strips on atrazine and metolachlor losses in surface runoff and subsurface infiltration from agricultural plots. *Journal of Environmental Quality*, 39(2): 617–629. DOI: 10.2134/jeq2009.0041

- **Couture, Raoul-Marie, Charles Gobeil** & **André Tessier** (2010). Arsenic, iron and sulfur co-diagenesis in lake sediments. *Geochimica et Cosmochimica Acta*, 74(4): 1238–1255. DOI: 10.1016/j.gca.2009.11.028

- **Drevnick, Paul**, A. Shinneman, C. Lamborg, D. Engstrom, M. Bothner & J. Oris (2010). Mercury flux to sediments of Lake Tahoe, California–Nevada. *Water, Air & Soil Pollution*, 210(1-4): 399–407. DOI: 10.1007/s11270-009-0262-y

- **Dumont, Dany, Yves Gratton** & T.E. Arbetter (2009). Modeling the dynamics of the North Water polynya ice bridge. *Journal of Physical Oceanography*, 39(6): 1448–1461. DOI: 10.1175/2008JPO3965.1

- **Fortin, Claude**, Y. Couillard, B. Vigneault & **Peter G.C. Campbell** (2010). Determination of free Cd, Cu and Zn concentrations in lake waters by *in situ* diffusion followed by a column equilibration ion-exchange method. *Aquatic Geochemistry*, 16(1): 151–172. DOI: 10.1007/s10498-009-9074-3

- **Gauthier, Charles, Peter G.C. Campbell** & **Patrice Couture** (2009). Condition and pyloric caeca as indicators of food web effects in fish living in metal-contaminated lake. *Ecotoxicology and Environmental Safety*, 72(8): 2066–2074. DOI: 10.1016/j.ecoenv.2009.08.005

- **Ponton, Dominic E.** & **Landis Hare** (2010). Nickel dynamics in the lakewater metal biomonitor *Chaoborus*. *Aquatic Toxicology*, 96(1): 37–43. DOI: 10.1016/j.aquatox.2009.09.011

Some research partners

- Environment Canada
- Imperial Oil
- Quebec's Ministry of Natural Resources and Wildlife
- ArcticNet and MITHE (Metals in the Human Environment) Networks
- Rio Tinto Alcan
- Vale Inco

INRS
Université d'avant-garde

Centre Eau Terre Environnement
Institut national de la recherche scientifique
490 de la Couronne | Québec (QC) Canada | G1K 9A9
418.654.2524 | info@ete.inrs.ca | www.ete.inrs.ca

INRS
Université d'avant-garde

Geosciences
2009-2010

Centre - Eau Terre Environnement

Geoscience research addresses several of the most important socio-economic issues that society currently faces.

The increasing demand for natural resources, the need for sustainable management of groundwater resources, the risks posed by natural hazards related to geological processes, and the impacts of climate change are all crucial issues for researchers in geological sciences.

The Centre Eau Terre Environnement and the Quebec division of the Geological Survey of Canada are partners within a scientific collaboration agreement between the INRS and Natural Resources Canada. This university–government partnership has created the most important multidisciplinary research group in geosciences in Canada, the Centre géoscientifique de Québec (CGQ).

Examples of research applied to current challenges

Drill cores can reveal more

Diamond drilling is typically the main expense of mineral exploration. But the data obtained from drill cores are often limited to qualitative descriptions and analysis of some metals, while much more information could be obtained. The new mobile laboratory for physical, mineralogical, and chemical characterization of rocks (LAMROC) of the INRS enables researchers to simultaneously measure several parameters (physical properties, chemical elements, mineralogy) in drill cores using a system unique in the world. These data will contribute to the effectiveness of mineral exploration.

Sediments are telling us tales

The Potrok Aike Laguna in southern Patagonia, Argentina, has almost 400-m-thick sediments. These provide an invaluable natural archive of data on past environments and climate of the Southern Hemisphere. A drilling campaign was conducted at the site in the fall of 2008 as part of an international research initiative. Sediment cores of about 100 m were recovered, the oldest of which are estimated to be 65 000 years old. Core analyses are underway. The results should tell us a lot about past environments in this southern region.

Working together toward sustainable management

AIn Quebec, groundwater is used as the main water supply in 90% of the inhabited area and supplies about 20% of the population. In spite of its importance, our knowledge on the subject is only fragmentary. Within the framework of a provincial study on groundwater led by Quebec's Ministry of Sustainable Development, Environment and Parks, an inter-institutional research group is conducting a collaborative project aimed at obtaining a precise picture of the groundwater resources in six regions of Quebec. The main goal is to contribute to the sustainable management of this vital resource.

Main study themes and researchers involved

HYDROGEOLOGY ADN GEOPHYSICS

Bernard Giroux | Applied geophysics
bernard.giroux@ete.inrs.ca

Erwan Gloaguen | Applied geophysics
erwan.gloaguen@ete.inrs.ca

René Lefebvre | Modeling and contamination
rene.lefebvre@ete.inrs.ca

Richard Martel | Contamination and rehabilitation
richard.martel@ete.inrs.ca

Claudio Paniconi | Hydrological modeling
claudio.paniconi@ete.inrs.ca

GEOLOGICAL ENVIRONMENTS AND NATURAL RESOURCES

Lyal Harris | Structural geology
lyal.harris@ete.inrs.ca

Michel Malo | Structural geology
michel.malo@ete.inrs.ca

Marc Richer-Laflèche | Geochemistry
marc.richer-lafleche@ete.inrs.ca

Pierre-Simon Ross | Volcanology and economical geology | pierre-simon.ross@ete.inrs.ca

ENVIRONMENTAL GEOLOGY

Bernard F. Long | Sedimentology
bernard.long@ete.inrs.ca

PALEOENVIRONMENTAL STUDIES

Yves Bégin | Dendroecology | yves.begin@ete.inrs.ca

Pierre Francus | Limnogeology
pierre.francus@ete.inrs.ca

Examples of recent publications

(INRS-ETE authors are in **bold**)

- Bédard, Jean H., F. Leclerc, **Lyal Harris** & N. Goulet (2009). Intra-sill magmatic evolution in the Cummings Complex, Abitibi greenstone belt: Tholeiitic to calc-alkaline magmatism recorded in an Archaean subvolcanic conduit system. *Lithos*, 111(1-2): 47–71.
  DOI: 10.1016/j.lithos.2009.03.013

- **Bordet, Ester**, **Michel Malo** & Donna Kirkwood (2010). A structural study of western Anticosti Island, St. Lawrence platform, Québec: a fracture analysis that integrates surface and subsurface structural data. *Bulletin of Canadian Petroleum Geology*, 58(1): 36–55.
  DOI: 10.2113/gscpgbull.58.1.36

- Camporese, M., **Claudio Paniconi**, M. Putti & S. Orlandini (2010). Surface–subsurface flow modeling with path-based runoff routing, boundary condition-based coupling, and assimilation of multisource observation data. *Water Resources Research*, 46: W02512.
  DOI: 10.1029/2008wr007536

- **Cloutier, Vincent**, **René Lefebvre**, Martine M. Savard & R. Therrien (2009). Desalination of a sedimentary rock aquifer system invaded by Pleistocene Champlain Sea water and processes controlling groundwater geochemistry. *Environmental Earth Sciences*, 59(5) : 977–994.
  DOI: 10.1007/s12665-009-0091-8

- **Collin, Antoine**, **Bernard Long** & P. Archambault (2010). Salt-marsh characterization, zonation assessment and mapping through a dual-wavelength lidar. *Remote Sensing of Environment*, 114(3): 520–530.
  DOI: 10.1016/j.rse.2009.10.011

- Denneler, B., Y. Bergeron & **Yves Bégin** (2010). Flooding effects on tree-ring formation of riparian Eastern White-Cedar (*Thuja occidentalis* L.), Northwestern Quebec, Canada. *Tree-Ring Research*, 66(1): 3–17.
  DOI: 10.3959/2008-11.1

- **Lewis, Jeffrey**, **Richard Martel**, **Luc Trepanier**, G. Ampleman & S. Thiboutot (2009). Quantifying the transport of energetic materials in unsaturated sediments from cracked unexploded ordnance. *Journal of Environmental Quality*, 38: 2229–2236.
  DOI: 10.2134/jeq2009.0019

- **Ross, Pierre-Simon** & Jean H. Bédard (2009). Magmatic affinity of modern and ancient subalkaline volcanic rocks determined from trace-element discriminant diagrams. *Canadian Journal of Earth Sciences*, 46(11): 823–839.
  DOI: 10.1139/E09-054

Some research partners

- Ouranos Consortium on Regional Climatology and Adaptation to Climate Change
- Government of Canada (National Defence, Justice)
- Government of Quebec (Sustainable Development, Environment and Parks; Natural Resources and Wildlife)
- JAG Mines
- DIVEX (DIVersification de l'EXploration minérale au Québec) Network
- TechnoRem

INRS
Université d'avant-garde

Centre Eau Terre Environnement
Institut national de la recherche scientifique

490 de la Couronne | Québec (QC) Canada | G1K 9A9
418 654-2524 | info@ete.inrs.ca | www.ete.inrs.ca

INRS
Université d'avant-garde

Decontamination and reclamation

2009-2010

Centre - Eau Terre Environnement

Waste needs to be managed as a resource if the sustainable use of natural resources is to be attained.

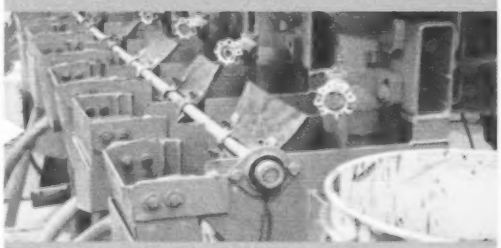
Cities and industries face major challenges with respect to waste recycling and reuse, and thus methods and technologies have to be adapted continuously.

The Centre Eau Terre Environnement is a leader in the development of environmental technologies. Its researchers possess unique expertise in the development of treatment and reclamation technologies of contaminated sewage sludge, effluents, and solid waste. Moreover, the Centre has one of the most complete and flexible pools of pilot equipment and analytical instruments in Canada for research and development projects. New technologies conceived at the Centre are regularly patented and transferred to industry.

Examples of research applied to current challenges

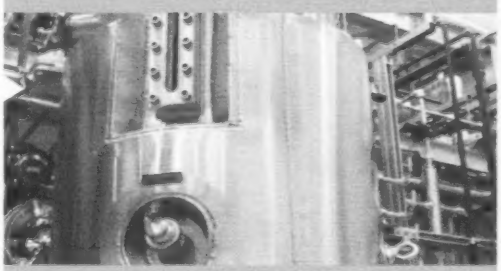
Mixed contamination, a complex issue

Treating soils contaminated by both metals and hydrophobic organic compounds (PAH, PCB, etc.) is complex and expensive. No technology is currently available to do this treatment in only one step at a reasonable cost. The technology being developed will allow metal extraction from contaminated soil by chemical leaching and PAH removal using a surfactant. This new process will thus fill a major gap in environmental decontamination technology.



To make more than cheese

Cheese factories face important problems of waste elimination. When milk is transformed into cheese, 90% of its volume ends up as whey, a by-product that is expensive to eliminate. Our current research looks at how to transform whey into a food ingredient rich in proteins and nutrients (Base-L) that can be used to feed animals. Optimization of the entire Base-L production process is underway.



Decentralized high-tech treatment

Wastewater treatment is a major environmental issue. New contaminants appear and treatment technologies must follow. New technologies of advanced oxidation are currently being developed to degrade refractory compounds (e.g., endocrine-disrupting chemicals) and simultaneously eliminate inorganic and microbial pollutants. The challenge is even greater for sites not connected to centralized treatment infrastructures. For those sites, electrolytic units that can produce oxidants *in situ* are being developed.

Main study themes and researchers involved

ENVIRONMENTAL DECONTAMINATION

Mario Bergeron | Hydrometallurgy
mario.bergeron@ete.inrs.ca

Jean-François Blais | Decontamination and reclamation | jean-francois.blais@ete.inrs.ca

Patrick Drogui | Electrotechnologies
patrick.drogui@ete.inrs.ca

Guy Mercier | Decontamination and reclamation
guy.mercier@ete.inrs.ca

Normand Tassé | Geochemistry
normand.tasse@ete.inrs.ca

BIOMASS AND WASTE RECLAMATION

Satinder Kaur Brar | Biological detoxification
satinder.brar@ete.inrs.ca

Rajeshwar Dayal Tyagi | Waste bioconversion
rd.tyagi@ete.inrs.ca

Examples of recent publications

(INRS-ETE authors are in **bold**)

- **Blais**, **Jean-François**, **Nathalie Meunier** & **Guy Mercier** (2010). New technologies for toxic metals removal from contaminated sites. *Recent Patents on Engineering*, 4(1): 1-6.
DOI: 10.2174/187221210790244794

- **Dermont**, **Gérald**, **Mario Bergeron**, **Marc Richer-Laflèche** & **Guy Mercier** (2010). Remediation of metal-contaminated urban soil using flotation technique. *Science of the Total Environment*, 408(5): 1199-1211.
DOI: 10.1016/j.scitotenv.2009.11.036

- **Gassara**, **Fatma**, **Satinder Kaur Brar**, **Rajeshwar Dayal Tyagi**, M. Verma & R.Y. Surampalli (2010). Screening of agro-industrial wastes to produce ligninolytic enzymes by *Phanerochaete chrysosporium*. *Biochemical Engineering Journal*, 49(3): 388-394.
DOI: 10.1016/j.bej.2010.01.015

- **Mohapatra**, **Dipti Prakash**, **Satinder Kaur Brar**, **Rajeshwar Dayal Tyagi** & R.Y. Surampalli (2010). Physico-chemical pre-treatment and biotransformation of wastewater and wastewater sludge - Fate of bisphenol A. *Chemosphere*, 78(8): 923-941.
DOI: 10.1016/j.chemosphere.2009.12.053

- **Mouton**, **Julia**, **Guy Mercier**, **Patrick Drogui** & **Jean-François Blais** (2009). Experimental assessment of an innovative process for simultaneous PAHs and Pb removal from polluted soils. *Science of the Total Environment*, 407(20): 5402-5410.
DOI: 10.1016/j.scitotenv.2009.06.042

- **Vu**, **Khanh Dang**, **Rajeshwar Dayal Tyagi**, **José R. Valéro** & R.Y. Surampalli (2010). Batch and fed-batch fermentation of *Bacillus thuringiensis* using starch industry wastewater as fermentation substrate. *Bioprocess and Biosysems Engineering*, 33(6): 691-700.
DOI: 10.1007/s00449-009-0391-0

- **Zaviska**, **François**, **Patrick Drogui**, **Jean-François Blais** & **Guy Mercier** (2009). *In situ* active chlorine generation for the treatment of dye-effluents. *Journal of Applied Electrochemistry*, 39(12): 2397-2408.
DOI: 10.1007/s10800-009-9927-x

Example of patent

- **Blais**, **Jean-François**, **Nathalie Meunier**, **Jean-Louis Sasseville**, **Rajeshwar Dayal Tyagi**, **Guy Mercier** & F. Hammy (2010). Hybrid chemical and biological process for decontaminating sludge from municipal sewage / Procédé hybride chimique et biologique de décontamination de boues d'épuration municipales. [Patent CA 2379928]
http://brevets-patents.ic.gc.ca/opic-cipo/cpd/eng/patent/2379928/summary.html?type=number_search

Some research partners

- National Research Council of Canada
- HET Corporation
- Quebec's Ministry of Agriculture, Fisheries and Food
- Oligesco
- Premier Tech
- Tecosol

INRS
Université d'avant-garde

Centre Eau Terre Environnement
Institut national de la recherche scientifique
490 de la Couronne | Québec (QC) Canada | G1K 9A9
418.654.2524 | info@ete.inrs.ca | www.ete.inrs.ca

Hydrology

Watershed hydrology

Monique Bernier's research objective is to evaluate how radar polarimetry data can be used to monitor physical properties of ice, snow, soil, and wetlands.

Her team is involved in an assessment of climate change impacts on sea ice and river ice and of the associated risks for the maritime infrastructure and the users' safety in six Inuit communities of Nunavik. The project is financed by Indian and Northern Affairs Canada with the collaboration of the Kativik Regional Government. Work underway comprises historical and present-day characterization of the ice using traditional knowledge and local observations and spatio-temporal characterization using satellite images. Transport Quebec leads the project with the collaboration of the Ouranos Consortium (www.ouranos.ca). Transport Quebec has also mandated the INRS to install and monitor six weather stations located near the studied coastal communities.

Camera recording ice movements, Quaqtaq, Nunavik, Quebec

Using RADARSAT data, this researcher's team produced maps of frozen soil distribution in two agricultural watershed areas and developed a new geospatial decision-support system for managing the risks associated with melting soils. This work is part of a project led by Agriculture and Agri-Food Canada within a program of the Canadian Space Agency.

She also pursued her collaboration in the Variability and Change in the Canadian Cryosphere project of the International Polar Year 2007-2008 and in the ArcticNet Network (www.arcticnet.ulaval.ca), in which she takes part in the project Permafrost and Climate Change in Northern Coastal Canada: Impacts and Adaptations for Communities.

Another goal of this researcher is to estimate wind resources. She leads the WESNet Network (Wind Energy Strategic Network, www.wesnet.ca) project High Resolution Surface Winds Mapping in the Coastal Zone from SAR Satellite Imagery.

One of the objectives of **Karem Chokmani**'s research activities is to improve the quality of estimates of snow distribution and properties obtained from satellite imagery. For Hydro-Québec, he improved a snow cover mapping algorithm developed at the INRS. The goal was to adapt the algorithm to the new generation of AVHRR (Advanced Very High Resolution Radiometer) sensors of the NOAA (National Oceanic and Atmospheric Administration) satellites.

Alain N. Rousseau's research goal is to improve hydrological numerical models for use in water resource management. His team is characterizing the geomorphology of slopes and developing a framework of analysis for the uncertainties underlying river flow simulations. They are also developing a statistical disintegration method for the precipitation simulated by a regional climate model (RCM), i.e., a method to distribute spatially at a resolution of 4 to 15 km precipitation that was simulated at a resolution of about 40–50 km (RCM grid size).

This researcher and his team are continuing their evaluation of the benefits of different agricultural best management practices for the water quality and biological integrity of a watershed. They collaborate to develop a scientific method to determine water consumption in Quebec for the area covered by the Agreement on the Sustainable Water Resources of the Great Lakes and St. Lawrence River Basin. They also studied the risks of contamination for Quebec City's water intake in the Saint-Charles River.

Monique Bernier, Karem Chokmani, Alain N. Rousseau and **André Saint-Hilaire** continued to work together within the Ouranos Consortium AQUALYSE 2 project studying the hydrological processes occurring in highly aqualysed minerotrophic peat bogs of the La Grande River watershed.

Jean-Pierre Villeneuve is helping to implement integrated watershed management approaches for the Câu River in Vietnam.

Environmental hydraulics

Normand E. Bergeron is particularly interested in fish habitats. He studies the river geomorphology of the winter habitat of trout. His research team uses PIT-tag (Passive Integrated Transponder) technology to model the success of fish passage through road culverts for a project financed by Transport Quebec. The Research Institute of Hydro-Québec is supporting another project of this team, aimed at adapting the PIT-tag technology to monitor fish movements in large rivers, where hydroelectric dams are built.

This researcher continued to collaborate with colleagues at the Centre on two projects. The first project, with **Patrice Couture**, is a study of the impact of *Didymosphenia geminata*, an invasive alga, on the number of juvenile salmon. The second project, with **Yves Secretan**, is a characterization of the winter transport of sediments in tributaries of the St. Lawrence River.

Didymosphenia geminata bloom, Gagnon stream, Restigouche, Quebec

Yves Secretan's research team continued the development of the H2D2 software for Environment Canada. They worked on parallel processing and source code distribution, and on validating the calculations. Sections of the St. Lawrence River between Montreal and Quebec City were used for the calculations.

Urban hydrology

Sophie Duchesne's research program focuses on mathematical modeling applied to the management of water resources and water-related infrastructure in urban areas. Her team works, for example, to improve the performance of the models used to evaluate the state of degradation of water and sewer lines. This work is done in collaboration with **Jean-Pierre Villeneuve.**

Alain Mailhot is particularly interested in the impact of climate change on the management of drainage and underground water-related infrastructure in Canadian cities. Working in collaboration with **Sophie Duchesne**, he leads a project of the Ouranos Consortium on the management of rainwater in urban areas. The objective of the project is to evaluate the impacts of climate change on existing infrastructure and to propose adaptation strategies to minimize long-term risks and maintain a reasonable level of performance for rainwater management systems.

Jean-Pierre Villeneuve's research program focuses on applied mathematical models and optimal management of water resources in natural watersheds and urban areas.

Statistical hydrology

Taha B.M.J. Ouarda is particularly interested in hydrometeorological extremes and in the development of statistical approaches to environmental problems. He holds the Canada Research Chair in Hydrometeorological Variable Assessment. He continues to work on local and regional estimates of river flows to assist in the design of hydraulic structures. He is contributing to a national assessment of hydroelectric potential for all Canadian rivers.

This researcher and his team have obtained data sets on daily river flows for all ungauged Great Lakes basins and have developed a tool to estimate those flows on a continuous basis. They are working to improve precipitation forecast models used in alert systems for extreme events using Bayesian data fusion methods. In collaboration with Environment Canada, they have been examining the impacts of climate change on floods and low water levels and developing statistical downscaling procedures. They also continue to develop statistical approaches for modeling ships' squat in the St. Lawrence waterway in collaboration with the Canadian Coast Guard.

The same research team has been looking at the consequences of climatic extremes under the auspices of Quebec's Action Plan on Climate Change. They first studied the relationships between climate and morbidity and then examined more closely the case of hip fractures. They also evaluated weather indicators and thresholds at which heat alerts should be released. Finally, they continued to work on modeling regional changes in climatic variability and extremes.

André Saint-Hilaire's research program focuses on statistical modeling of abiotic variables characterizing aquatic habitats (temperature, sediment, flow). With his research team, he inventoried the environmental indicators of agricultural ecosystems health for Agriculture and Agri-Food Canada.

His research team has been involved in two projects with Fisheries and Oceans Canada: 1) selection of the hydrological indices useful to estimate in-stream flow needs, and 2) review of the construction standards for sedimentation basins located downstream from exploited peat bogs and the impact of these basins on the rivers' sedimentary loads, the latter project in collaboration with Premier Horticulture.

In a project of the Ouranos Consortium on river thermal refugia for salmon, this researcher's team is collaborating with **Normand E. Bergeron** to model water temperature under different scenarios of global warming.

André Saint-Hilaire and Anik Daigle, Rouge stream temperature and flow measurements, Beauport, Quebec

André Saint-Hilaire and **Taha B.M.J. Ouarda**, continued to work together on three research projects: a project to model the thermal regime of salmon streams in Quebec and New Brunswick, a statistical analysis of the water quality measurement network in Lake Winnipeg, and a collaboration with the ENSEMBLES European Consortium.

Biogeochemistry and contamination issues

Aquatic ecotoxicology

Peter G.C. Campbell's research interests relate to the development of models to predict bioavailability of trace metals in aquatic organisms in natural environments. He holds a Canada Research Chair in Ecotoxicology of Metals.

Peter G.C. Campbell and **Claude Fortin**'s research teams are collaborating with Environment Canada on an evaluation of the use of QICAR (Quantitative Ion Character Activity Relationships) to predict metal speciation and toxicity. They also pursued the development of tools to quantify the bioavailability of trace metals in aquatic environments.

Patrice Couture has started a new research program on the combined effects of natural and anthropogenic (metal contamination, climate change) stress factors on fish and aquatic invertebrates.

Patrice Couture and **Peter G.C. Campbell**'s research teams are collaborating on a ecotoxicogenomic project in partnership with the mining company Vale Inco. The project's objective is to develop a DNA microarray to detect stress related to metal contamination in yellow perch, the most common fish in mining regions. Various stress indicators (genomic, physiological, biochemical) will be compared in order to better understand the interactions that can affect fish health in natural environments.

Paul Drevnick's research program focuses on understanding the processes of mercury methylation and toxicity in fish in order to make recommendations to fisheries managers.

Claude Fortin also works to improve predictive models of the bioavailability of trace elements in aquatic environments. With his research team, he carried out a literature review for Environment Canada of the sources, fate, bio-accumulation, and toxicity of platine group elements. They also completed a project in partnership with industry on the potential of green algae to accumulate and adsorb aluminum.

This researcher has obtained financing from the Canadian Foundation for Innovation for a new analytical laboratory on the mechanisms of metal assimilation and detoxification in freshwater organisms. This laboratory will enable measurement of trace elements in a diversity of natural matrices.

Landis Hare's research program is to develop models to predict the contamination state of lakes and rivers from measurements made on aquatic organisms.

Patrice Couture, **Claude Fortin** and **Landis Hare** have completed their contribution to the project on the transfer of trace metals along aquatic food chains within the MITHE (Metals in the Human Environment) Network (www.mithe-sn.org), the network having ended its activities this year. They also carried out a literature review for Environment Canada on the environmental impacts of thallium in aquatic environments.

Environmental geochemistry

Claude Fortin and **Alain N. Rousseau** completed their assessment of the impacts of forest harvesting on the chemical composition of alkaline lakes in the Gaspésie region. This work was done in collaboration with Quebec's Ministry of Natural Resources.

Charles Gobeil is continuing his work on the alterations of the biogeochemical cycles of trace elements and organic carbon in oceans and lakes. He focuses on long-distance atmospheric transport of trace metals, identification of contamination sources, and environmental changes (eutrophication, acid rain, global warming). He has led projects on the sediments of the Arctic continental margins and on lakes of the Canadian Shield and the Appalachian Mountains. **André Tessier** collaborates on some of these projects.

Pierre Lafrance's research program concerns the influence of biophysico-chemical processes on the fate and transport of pesticides in surface and groundwater. Working in collaboration with **Alain N. Rousseau**, he is analysing the capacity of agricultural best management practices (e.g., vegetative riparian strips) to reduce the transfer of pesticides to streams. Agriculture and Agri-Food Canada finances this project.

Limnology

One of **Isabelle Laurion** 's research objectives is to evaluate the consequences of permafrost melting on the thermal and light regimes of northern aquatic environments and their influence on microbial productivity and gas exchanges. In temperate regions, she examines greenhouse gas emissions from small water bodies affected by cyanobacterial bloom. With her research team, she seeks to understand the role of these environments in the carbon and nitrogen cycles, particularly in the context of global warming and lake eutrophication.

This researcher continued to collaborate on CICAT (Climate change Impacts on Canadian Arctic Tundra ecosystems, ipytundra.ca) a project of the International Polar Year 2007-2008, and on the ArcticNet project Freshwater Resources of the Eastern Canadian Arctic. She is also involved in a study of the mercury cycle in northern environments affected by climate change.

Paul-Georges Rossi, wind speed measurements for water atmosphere gas exchange models, Bylot Island, Nunavut

Oceanography

Yves Gratton is particularly interested in the physical processes that control water mass displacement and mixing in the Arctic Ocean. His team participated in a study of the response of Arctic ecosystems to climate change.

This researcher also contributed to two projects of the International Polar Year 2007-2008: the Circumpolar Flaw Lead System Study (www.ipy-cfl.ca) and the Canadian Arctic SOLAS Network (www.quebec-ocean.ulaval.ca/C-Solas). He also leads the Long-Term Observatories in Canadian Arctic Waters project within the ArcticNet Network. He focuses on two main aspects: water column physical characteristics and marine biodiversity hot spots.

Amundsen Research Icebreaker, Beaufort Sea, Canadian Arctic

Geosciences

Hydrogeology and geophysics

Bernard Giroux carried out two research contracts on the Îles-de-la-Madeleine. The first one, financed by the Canadian Coast Guard, was designed to evaluate the potential of georadar to detect sandbags and hydrocarbon aggregations. The second contract, financed by Quebec's Ministry of Public Safety, was a feasibility study of the use of georadar to map karst formations along the coast of the islands.

Erwan Gloaguen's work is based on the stochastic integration of geophysical imagery measurements, with the objective of increasing our knowledge of soil properties for environmental, mining, or energy purposes. He is interested in multi-scale integration of imagery data, not only in geophysics but also in the biomedical field.

This researcher and his team carried out electrical and radar surveys to determine the optimal positioning of a drinking water well for an aboriginal community of Quebec. They also took part in characterization of a site containing unexploded ordnance and in inspections of ice roads in northern Quebec.

René Lefebvre's research activities concern the characterization and modeling of the heterogeneity of aquifers. He provided expert hydrogeological advice relating to the presence of trichloroethylene (TCE) in groundwater around the Valcartier Garrison.

René Lefebvre at the Centre and **Christine Rivard** at the Geological Survey of Canada (GSC) are coordinating a project to characterize the groundwater in Montérégie-Est. **Erwan Gloaguen**, **Richard Martel** and **Claudio Paniconi** of the Centre and **Michel Parent** of the GSC are also involved. Resource characterization and hydrological and hydrogeologic modeling are planned.

Michel Malo holds the Research Chair in Geological Sequestration of CO_2 (chaireco2.ete.inrs.ca). The chair's team includes several of his colleagues at the Centre (**Bernard Giroux**, **Erwan Gloaguen**, **René Lefebvre**, **Marc Richer-Laflèche**, and **Normand Tassé**) and **Mathieu J. Duchesne** of the GSC.

Richard Martel is particularly interested in groundwater contamination caused by ammunition residues in military training areas. His research team continues to examine the evolution in the environment of energetic materials in collaboration with Defence Research and Development Canada. They study groundwater and soil contamination in the laboratory and in the field on the sites of several Canadian military bases. **Erwan Gloaguen**'s team works on stochastic modeling of the Valcartier base's aquifer. **Michel Parent** of the GSC participates in some of this work.

Richard Martel and **René Lefebvre**'s research teams completed a project in partnership with industry on the effect of surfactant solutions on the performance of restoration techniques for petroleum-contaminated aquifers.

Richard Martel and his colleagues **Marc Richer-Laflèche** and **Lyal Harris** continued to offer scientific support to the Government of Quebec's strategy for public health protection against radon in homes.

Claudio Paniconi's research interests mainly relate to hydrological modeling. A study is underway on the interactions between surface water and groundwater in the Châteauguay River watershed. Several researchers collaborate on this project of the Ouranos Consortium, including **René Lefebvre** and **Alain N. Rousseau** of the Centre and **Miroslav B. Nastev** of the GSC.

Geological environments et natural resources

Erwan Gloaguen's research team continued to work on modeling ore contents of a Vale Inco Ni-Cu deposit using stochastic seismic tomography. They also work on modeling gas hydrate reservoirs for the Mallik site.

Lyal Harris has completed structural and tectonic interpretation of gravimetric and aeromagnetic data for the company Laurentian Goldfields. With his team, a[illegible] in collaboration with **Marc Richer-Laflèche** they finalized data interpretation for sectors of the Grenville geological province and undertook new field work in other areas as part of a project financed by DIVEX (*DIVersification de l'EXploration minérale au Québec*, www.divex.ca), Richmond Minerals, and Fort Chimo Minerals.

Lyal Harris collaborates with GSC researchers on two projects: a study of the geology of the Bondy complex (Grenville province), conducted with **Louise Corriveau** and the company Richmond Minerals, and a project on the geology of the Chibougamau region, conducted with **Jean H. Bédard** within the framework the 3rd Targeted Geoscience Initiative (TGI-3).

Michel Malo's research interests concern the natural resource potential (hydrocarbons and metals) of mountain range orogenetic fronts. His team has focused on the oil potential of the Gaspésie in partnership with the company Pétrolia, the French Petroleum Institute, and the Geological Survey of Canada. They also worked on new mineral exploration guides for this area using relationships between geochemical and geophysical data and mineral-bearing indices and known deposits.

Michel Malo is the co-director of the DIVEX Network. His team is working in collaboration with **Benoît Dubé** of the GSC on a project of the network that seeks to understand the relationships between the Lake Ell Cu-Au-Ag mineralization and the gold mineralization of the Roberto deposit of the Éléonore property in James Bay.

Marc Richer-Laflèche eand his team continue their evaluation of the gas potential at JAG Mines properties in Quebec. A regional gravimetric study and radiometric and pedogeochemical surveys are underway in Témiscouata. Another gravimetric study has been carried out in the Gouffre River basin in Charlevoix, where pedogeochemical surveys of hydrocarbons are ongoing. Similar work has been done in the Lake St-Jean region.

Pierre-Simon Ross's research program relates to maar-diatreme volcanoes, submarine volcanic rocks, and volcanogenic massive sulphide (VMS) deposits. With his research team and collaborators within the DIVEX Network, he pursues the development of tools and concepts for VMS exploration in the Matagami area. This researcher also participates in a multidisciplinary study of the Blake River Group in Abitibi. His contribution focuses on the geological and volcanological context of VMS. A volcanological and metallogenic study of the Hébécourt rhyolite is underway in collaboration with **Patrick Mercier-Langevin** of the GSC.

The new mobile laboratory for physical, mineralogical, and chemical characterization of rocks (LAMROC) has enabled **Pierre-Simon Ross**'s research team to initiate the set up and development of a large multiparameter data bank for the Matagami area.

LAMROC mobile laboratory

Paleoenvironmental studies

Yves Bégin has started a new phase of research relating to the seasonal hydrological extremes at the Boreal–Subarctic interface in eastern Canada. The goal is to document historical floods and low water levels using natural archives (dendrochronology and paleosoils). This researcher's team has completed a dendroclimatic analysis in the nesting area of boreal birds for the Canadian Wildlife Service (Environment Canada).

The ARCHIVES (*Analyse Rétrospective des Conditions Hydroclimatiques à l'aide des Indicateurs de leur Variabilité à l'Échelle Séculaire*, archives.ete.inrs.ca) project continues in collaboration with several researchers from Europe and Quebec (at the Centre, **Pierre Francus**, and at the GSC, **Christian Bégin** and **Martine M. Savard**). This project operates within the ArcticNet Network and the Centre d'études nordiques.

Pierre Francus' research program focuses on the reconstruction of past climates from annually laminated lake sediments, mostly in the Canadian Arctic. In addition, he participated in the formation of a training and research group in marine geology and paleoclimatology within the Université du Québec network.

With his research team, he continued to collaborate on the project on thermokarst ponds in northern Canada and on the Cape Bounty Arctic Watershed Observatory (geog.queensu.ca/cbawo) project of the International Polar Year 2007-2008. This researcher leads the Canadian contributions to two international initiatives: PASADO (Potrok Aike Maar Lake Sediment Archive Drilling Project, can-pasado.ete.inrs.ca) and ICDP (International Continental Scientific Drilling Program, www.icdp-canada.ca).

Environmental decontamination and waste reclamation

Environmental decontamination

Jean-François Blais' research program concerns the treatment of solid and liquid matrices polluted by toxic metals and other contaminants. He holds the Canada Research Chair in Environmental Decontamination.

The research teams of **Jean-François Blais**, **Guy Mercier**, and **Patrick Drogui** continued to work on the decontamination process they have developed for chromated copper arsenate–treated wood. The objective of the current research phase is to enable the reuse of both the wood preservatives extracted and the decontaminated wood.

Patrick Drogui's research interests relate to the development of new technologies to remove pollutants from municipal and industrial wastewater. His research team mainly focuses on electrotechnologies. He collaborates with research teams from several countries (Tunisia, Morocco, France, Mexico, China), sharing expertise in water treatment and effluent decontamination. Student fellowships are an important part of these collaborations.

His research team also started a new partnership with Premier Tech aimed at developing electrolytic units to simultaneously degrade endocrine-disrupting chemicals and remove inorganic and microbial pollutants from wastewater. This project is carried out in collaboration with the research teams of **Jean-François Blais** and **Guy Mercier**.

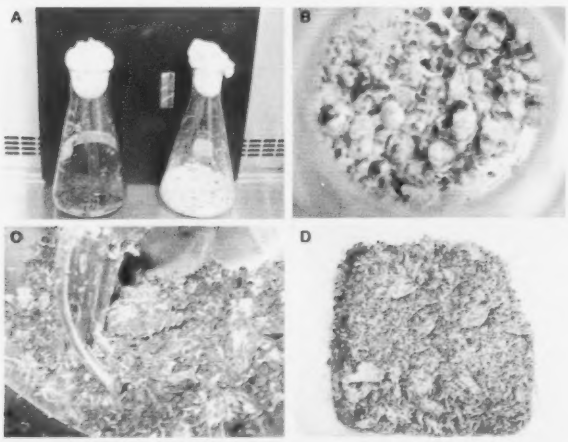
Guy Mercier works on developing treatment and reclamation technologies for matrices contaminated by metals and/or PAH (Polycyclic Aromatic Hydrocarbons). His research team is developing a single-step process to treat soils contaminated by both metals and hydrophobic organic compounds (PAH and others). This project is a partnership with the company Tecosol and is carried out in collaboration with **Jean-François Blais**' and **Patrick Drogui**'s research teams. This same group has also finalized improvements to the LISOX technology (for the treatment of liquid pig manure) in partnership with HET Corporation.

Biomass and waste reclamation

Mario Bergeron's research team continued the development of a new production process for chlorosilanes. These chemical compounds are the base material used in the optical fibre, solar panel, and semiconductor industries. The technology could eventually be used to recycle waste from these industries.

Satinder Kaur Brar's research work concerns the production of value-added bioproducts (biopesticides, enzymes, and others) using industrial and municipal waste. She and her research team focuses in particular on the products' formulation for their application in the field and for their marketing. They are also interested in the degradation of emergent contaminants (bisphenol A, pharmaceutical products, etc.) and other endocrine-disrupting chemicals.

The same research team is working on a project on reclamation of solid and liquid residues of the fruit processing and juice producing industry. The goal is to produce ligninolytic enzymes and other biochemical products (e.g., citric acid) using these residues. They also seek to extract polyphenolic compounds (antioxidants) and then reuse the residual biomass to feed animals. **Rajeshwar Dayal Tyagi**'s research team is involved in this project.



A) Fruit solid residues (left) and fermented residues for producing ligninolytic enzymes (right); B) Growth of Phanerochaete on fruit pomace; C) Pomace after fermentation; D) Animal food product..

Guy Mercier's and **Jean-François Blais**' research teams have begun a new project aimed at developing a CO_2 sequestration process using asbestos residues in order to reduce the industrial emissions of this greenhouse gas. The possibility of producing magnesium carbonate from this process will be evaluated.

Rajeshwar Dayal Tyagi's research objective is also to produce value-added products. He is particularly interested in the decontamination of sewage sludge. He holds a Canada Research Chair on the Bioconversion of Wastewater and Sewage Sludge into High-Value-Added Products.

This researcher's team continued the development of effective formulations of bio-inoculants, biofertilizers, and biopesticides based on *Rhizobium* and *Trichoderma* using wastewater and sewage sludge. Liquid formulations of *Bacillus thuringiensis*, a biopesticide used to control spruce budworm, were also developed. His team has started a new project in partnership with HET Corporation aimed at producing animal food from whey, a by-product of the cheese industry. **Satinder Kaur Brar**'s research team is involved in these three projects.

INRS
Université d'avant-garde

Research facilities

Centre - Eau Terre Environnement

The Centre's high-tech laboratories and specialized equipment combine with its researchers' high level of expertise to contribute to the Centre's mission of education, applied research, and innovation.

The Centre's main infrastructure comprises modern research laboratories, pre-industrial-scale laboratories, mobile facilities, and a research station.

The **research laboratories** are located in a downtown building on the urban campus of the Université du Québec in Quebec City. They include a very complete set of analytical equipment essential for advanced research work, and extensive modeling and data processing capacities. For example, the Centre possesses a class 1000 clean room with a class 100 workspace, controlled environmental chambers, and the necessary equipment to prepare geological samples.

The **large-scale laboratories** are located in the Metropolitan Quebec Technology Park. Among other purposes, these laboratories are used for the scaling of technologies developed in partnership with industry. The pre-industrial experimental equipment is used to analyse the economic viability of technological innovations. These laboratories constitute a major asset for Quebec and Canadian enterprises.

Large-scale laboratories in the Technology Park

The Centre also has **mobile facilities** enabling on-site specialized work in environmental decontamination, hydrogeology, and geological analysis.

A **research station**, located at Sacré-Cœur in the Saguenay region near the mouth of the Sainte-Marguerite River, offers the Centre's research teams a workspace in a natural environment of exceptional quality. The station comprises a laboratory and accommodations for up to 30 persons.

These facilities support applied innovative research related to hydrology, biogeochemistry, geological sciences, and environmental decontamination and waste reclamation.

Research station in the Saguenay region

These powerful tools for innovation and the Centre's high level of expertise are accessible to enterprises and governments via collaborative research projects oriented towards their specific needs. The Centre thus offers an exceptional opportunity for economic actors and regulatory agencies to contribute to the improvement of knowledge while serving their respective missions.

FOR MORE INFORMATION, PLEASE CONTACT:
Carole Parent, liaison officer, carole.parent@ete.inrs.ca, 418 654-2531

RESEARCH LABORATORIES

The research laboratories comprise a general laboratory and several specialized laboratories as well as microscopy and sample preparation rooms. The specialized laboratories enable the analysis of water samples by colorimetry, fluorometry, radio-isotopy, and chromatography, the analysis of organic compounds and trace metals contained in various matrices (water, effluent, sewage sludge, soil, sediment, biological tissues), and the analysis of different elements contained in solid samples (rock, soil, sediment, sludge). The Centre's analytical equipment and specialized software contribute to experimental research in a variety of fields.

FOR MORE INFORMATION, PLEASE CONTACT:
Stéfane Prémont, head of laboratory services, stefane.premont@ete.inrs.ca

X-ray fluorescence scanner

A non-destructive tool for chemical analysis by XRF (X-ray fluorescence) scanning and micro-radiography analysis of rocks and sediment cores

The **ITRAX™** core scanner enables the simultaneous acquisition of very high resolution (100 µm) data on density, structural, and compositional variations of samples; it can also conduct optical imaging. Most elements can be measured using XRF, from aluminum to uranium. Rocks, powder, and split sediment cores and U-channels of up to 1.8 m in length can be analysed.

One of the uses of this equipment is to analyse lake and marine sediments in order to reconstruct past climates at various temporal scales.

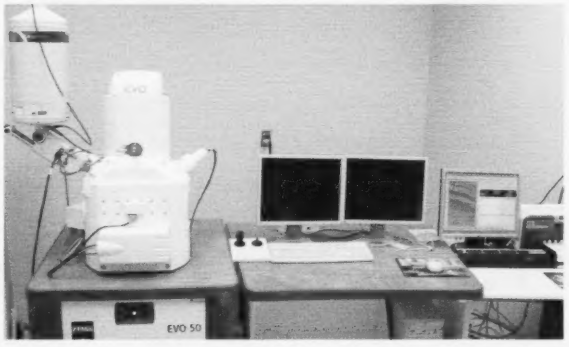
ITRAX™ XRF core scanner

Scanning electron microscope

Based on the interactions between electrons and a sample's atoms, this technology enables high-resolution imaging of the surface of a sample

Using the **Zeiss EVO® 50** scanning electron microscope (SEM), it is possible to obtain images of the surface of most solid materials, with magnifications from 100X to 60 000X.

The SEM is equipped with three types of detectors for various applications: morphological characterization (secondary electron detection), phase atomic density and granulometry (backscattered electron detection), and chemical composition analysis and elemental distribution mapping (x-ray detection). The SEM can be used to observe samples in controlled-pressure environments, eliminating the need for preliminary metallization.



Scanning electron microscope (SEM)

CONTACT:
Dr. **Pierre Francus**, pierre.francus@ete.inrs.ca

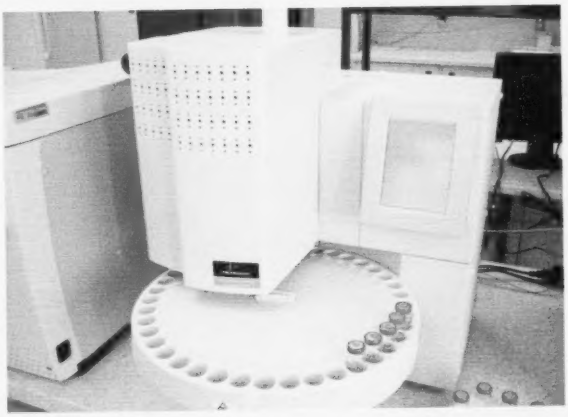
Aquatic biogeochemistry and limnology

Analysis of trace metals in liquid or solid samples (biological tissues, suspended matter, sediment, soil) and bio-optical analysis

The main instruments used for trace metal analysis are:

- Radioactivity and particle counters (beta and gamma emissions)
- Atomic absorption spectrophotometer (combined flame and graphite furnace)
- Inductively coupled plasma atomic emission and mass spectrometers (ICP-AES and ICP-MS)
- Liquid, gas, and ion chromatography systems (HPLC, LC-MS-MS, GC, GC-MS)
- Mercury analyzer

These instruments support research on the transfer of toxic metals within food chains, the bioavailability of contaminants, the impacts of anthropogenic activities, and the sensitivity of the natural environment to metal contamination.



Gas chromatography system

Limnology work focuses on the impacts of climate change on water mixing dynamics and transparency in lakes, and on their interaction with the microbial food chain. Bio-optical work focuses on counting and characterizing microorganisms, monitoring their fluorescence, describing their morphometry and taxonomy, and studying their physiology.

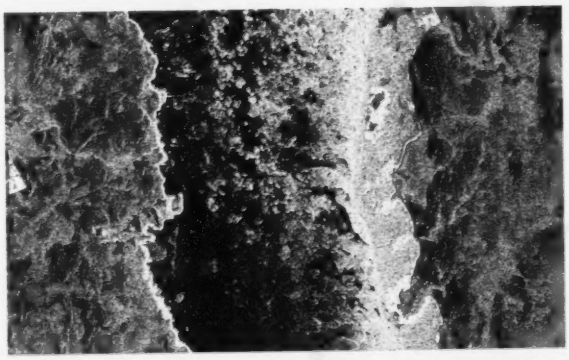
CONTACT:
Stéfane Prémont, stefane.premont@ete.inrs.ca

Applied remote sensing

Analysis of earth observation images to map and model different processes, particularly those related to water resources in northern environments

Satellite radar (RADARSAT, ASAR, TerraSAR-X) and optical (GeoEye, Quickbird, Ikonos, NOAA) imagery enables researchers to develop applications to measure and monitor water resources, the cryosphere (snow, ice, frozen soil), and wind resources. The Centre possesses several hundred images along with specialized software to process and analyse those images (Geomatica®, eCognition, ArcGIS, and MATLAB®).

Field measurements (with snow sampler, georadar, GPS and camera, weather stations, and moisture probes) are used to calibrate and validate the algorithms developed.



RADARSAT-2 image centred on Kuujjuaq harbour (© MDA and Canadian Space Agency)

CONTACTS:
Dr. **Monique Bernier**, monique.bernier@ete.inrs.ca
Dr. **Karem Chokmani**, karem.chokmani@ete.inrs.ca

Hydrology

Several hydrological modeling software programs have been developed by the Centre's researchers for specific needs. Field work is also an important component of hydrology research.

Hydrological numerical models to assist statistical analysis and river hydraulic studies

HYFRAN: HYFRAN is a statistical adjustment software program that includes a whole set of mathematical tools for the statistical analysis of data series, including, in particular, the statistical analysis of extreme events.
www.ete.inrs.ca/activites/groupes/chaire_hydrol/chaire9.html

H2D2/MODELEUR: H2D2 is a finite-element software program that is modular and extendable for applications in river hydraulics. It can be used coupled to MODELEUR (a specialized GIS). H2D2 is used in studies related to civil engineering, navigation, sediment transport, and the availability of fish habitats, among other issues.
www.gre-ehn.ete.inrs.ca/H2D2

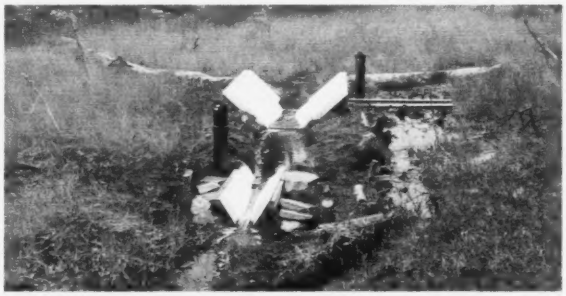
Hydrological numerical models to assist surface water management at the watershed scale

HYDROTEL/PHYSITEL: HYDROTEL is a distributed hydrological model combining remote sensing data and geographic information system (GIS) data. This model can simulate a whole set of hydrological processes. PHYSITEL, a specialized GIS, enables database formatting for various distributed hydrological models. In the context of sustainable development and climate change, the demand for such tools is increasing in order to better predict inflows to hydroelectric reservoirs and maximum flood levels (for dam safety). These tools are also used to study the role of wetlands within the hydrological cycle of watersheds.
www.ete.inrs.ca/activites/modeles/hydrotel/en/accueil.htm

GIBSI: GIBSI is an integrated modeling and data management system for watersheds that includes a database management system and a GIS. It supports decision-making by enabling water managers to explore different strategies at the watershed scale (e.g., assessment of beneficial management practices in agriculture; management of contamination risks for drinking water sources).

Boreal hydrology *in situ* measurements

Experimental research in boreal hydrology includes analysis of water retention, hydraulic conductivity, and infiltration properties in soil columns and samples using laboratory setups (tension tables, disk and double disk infiltrometers, and infiltration columns). It also includes the study of water flows, hydrological balance, and isotope presence at the scale of peatlands and watersheds using field measurements (water table levels, weather data, and trapezoidal channel experiments).



Monitoring of water flows in a peatland

CONTACT:
Dr. **Alain N. Rousseau**, alain.rousseau@ete.inrs.ca

LARGE-SCALE LABORATORIES

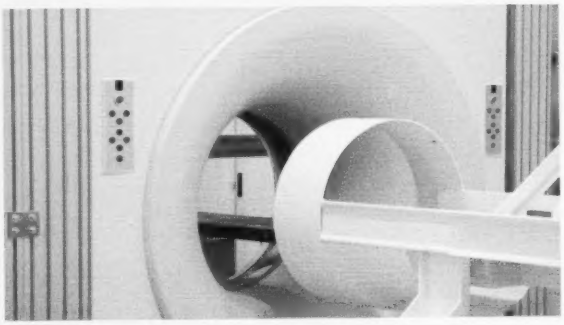
These laboratories host the larger research equipment not compatible with conventional laboratories and applied research pre-industrial units that require a more robust work environment.

Computer tomography scanner

Non-destructive measurements of the interior of natural or artificial solid bodies using density microvariations to determine the internal structure, the fracture and microfissure networks, the porosity, and the homogeneity of the analysed bodies

This modified medical equipment enables 3D study of fluid structures and flows within a volume created from repeated sequences of 64 simultaneous images with submillimetre precision and sensitivity to density variations of 0.1%.

This equipment possesses several features that give it flexibility for different applications. The **Siemens SOMATOM Sensation 64** scanner is installed on 3.5-m-long rails and has a 70-cm-diameter opening and source/sensor pairs enabling 360° measurements around the analysed body. The facility also includes instruments such as a laser granulometer, aquariums and pressure compartments to measure bioturbation, and a hydraulic channel to reproduce one-way currents, swell and gravity movements. This channel comprises instruments such as PIV, ADCP and ADV current profilers, resistivity probes, OBS, and cameras.



SOMATOM Sensation CT scanner

This equipment can be useful for numerous research fields: marine engineering, geological engineering, hydrogeology, sedimentary dynamics, environmental studies, dendrochronology, micropaleontology, biology, marine ecology, biogeochemistry, metallogeny, petrography, and archaeology.

CONTACT:
Dr. **Bernard Long**, bernard.long@ete.inrs.ca

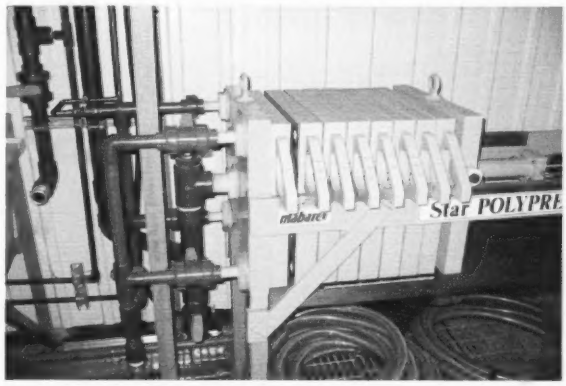
Decontamination

Implementation of environmental technologies at a pre-industrial scale to develop or optimize decontamination methods for liquid and solid residues using chemical, physical, biological, and electrochemical processes

Different modular units can be assembled to develop treatment methods adapted to specific decontamination needs. Liquid residues that can be treated include contaminated groundwater and municipal, industrial, and agroalimentary wastewater. Decontamination processes for solid residues can apply to soil, industrial waste, hazardous material, and sewage sludge. Some experimental setups can address complex issues such as mixed contamination or contamination implying refractory pollutants.

The main modular units are:

- Lamellar clarifier
- Bioflotation/biofiltration/membrane bioreactor
- Filter press
- Tray filter
- Centrifuge
- Rotary ring press
- Ion exchanger
- Adsorption column
- Electro-oxidation and electrodeposition unit
- Electrocoagulation and electroflotation unit
- Electromembrane unit
- Membrane units (microfiltration, ultrafiltration, nanofiltration, reverse osmosis)
- Voltamperometric unit (galvanostat/potentiostat)
- Screening unit
- Magnetic separator
- Shaking table
- Fluidized bed
- Flotation cell



Filter press for sludge dewatering

CONTACTS:
Dr. **Jean-François Blais**, jean-francois.blais@ete.inrs.ca
Dr. **Patrick Drogui**, patrick.drogui@ete.inrs.ca
Dr. **Guy Mercier**, guy.mercier@ete.inrs.ca

Bioprocesses

Small-scale implementation of the main steps of biological transformation of waste in order to develop or optimize processes used to obtain added-value products

All steps of the conversion process can be carried out using modular units, including conditioning of the raw material, waste transformation, and recovery of the end product. The equipment, installed in a food-grade workspace, is used to develop, optimize, and scale new bioprocesses. The added-value products obtained can be biopolymers, biopesticides, biofertilizers, biofuels, antioxidants, enzymes, and proteins.

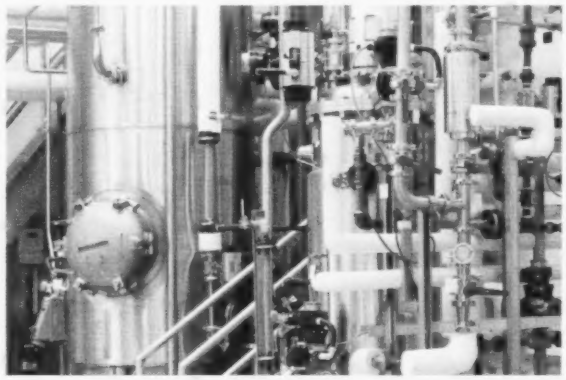
Two hydrolyzers (of 150- and 2000-litre capacity) are used to prepare the culture medium. For fermentation, the facility includes two instrumented fermentation lines, each having its own bioreactors (of 5-, 15-, 150-, and 2000-litre capacity).

The last step, recovery of the end product, uses the following modules:

- Continuous centrifuge
- Microfiltration and ultrafiltration unit
- Protein separation system using chromatography and ion exchange
- Spray dryer to obtain powder or granules
- Freeze dryer

The main analytical instruments used are:

- Flow cytometer
- DNA thermal cycler
- Electrophoresis system



2000-litre capacity hydrolyzer

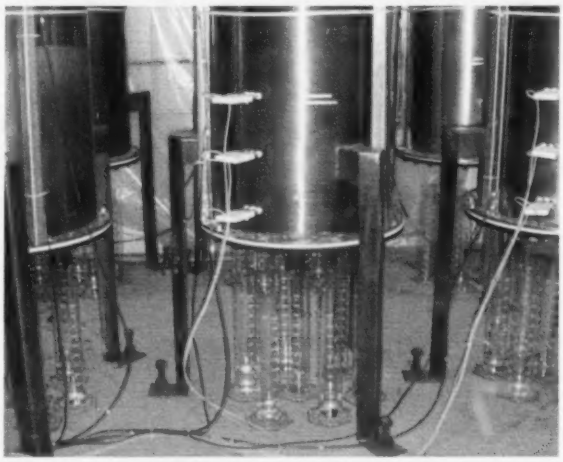
CONTACT:
Dr. **Rajeshwar Dayal Tyagi**, rd.tyagi@ete.inrs.ca

Soil and groundwater contamination

Study of soil contaminant behaviour and development of *in situ* treatment procedures at a scale intermediate between the laboratory and the field

The following equipment is used to simulate groundwater flows, monitor contaminant transport, and test new decontamination technologies for soil and groundwater, particularly for refractory contaminants or complex contamination contexts:

- Two reservoirs of 4 and 9 m^3 to test *in situ* decontamination technologies equipped with injection, pumping, and sampling wells
- Stainless steel columns to test different passive methods (natural attenuation, reaction wall)
- Stainless steel column segments to compare different active methods (air sparging, venting, biodegradation, soil washing with surfactants, and chemical oxidation)
- Laboratory cooled to groundwater temperature (8 °C)



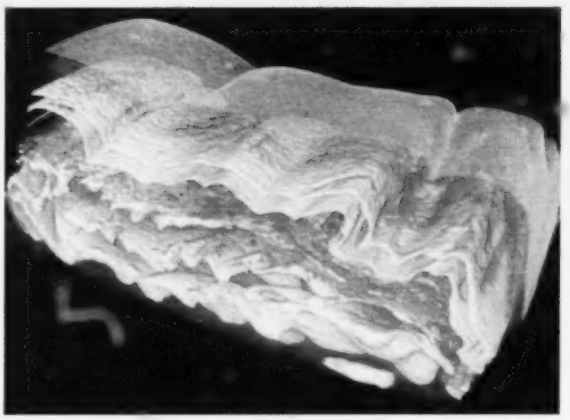
Monitoring of contaminant transfer through soil columns

CONTACT:
Dr. **Richard Martel**, richard.martel@ete.inrs.ca

Geodynamics

Structural and tectonic interpretation of field and geophysical data and simulation of geological processes to assist mineral and oil prospecting

Field studies and advanced geophysical data processing combined with physical, numerical, and geophysical simulations enable researchers to interpret the geometry and evolution of geological structures and to identify the structural and tectonic controls of mineral deposits and oil traps. The progressive deformation of the physical simulation models can be observed using tomodensitometry.



3D image of a model of folding in a channel flow

The main equipment includes:

- Work stations equipped with interactive screens and specialized software for geophysical data processing (Oasis Montaj™ and GM-SYS 2D extension, Geosoft), geotechnical 2D analysis (UDEC™ 5.0, Itasca), 3D reconstruction (GOCAD®, Gocad Research Group), and PIV imagery (StrainMaster, LaVision)
- Sandboxes, which are used to perform deformations (controlling for speed and constraints) to simulate brittle and brittle–ductile deformation of rocks, effects of basement structure, and pluton formation
- High-speed centrifuge, which enables the scaling of deformation models (made of plasticine and silicone mastic) to simulate the ductile deformation of rocks and diapirism

CONTACT:
Dr. **Lyal Harris**, lyal.harris@ete.inrs.ca

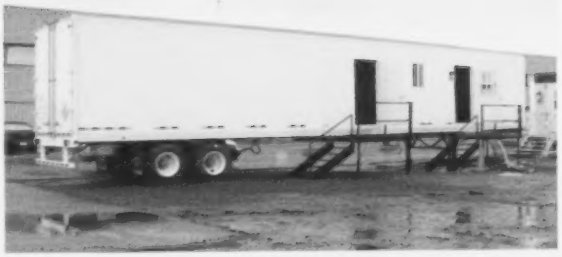
MOBILE FACILITIES

These facilities are used to carry out on-site tests and analyses. A modified truck serves as a biogeochemistry laboratory to prepare and process field samples directly on-site.

Environmental technologies

Testing decontamination technologies in real conditions

This mobile facility is used to test a whole set of decontamination technologies directly on the sites where the wastewater or contaminated soils are produced. The trailer can accommodate various treatment units that can be specifically assembled to meet different decontamination needs.



Mobile decontamination laboratory

CONTACTS:
Dr. **Jean-François Blais**, jean-francois.blais@ete.inrs.ca
Dr. **Guy Mercier**, guy.mercier@ete.inrs.ca

Aquifer characterization

Development of detailed characterization techniques for aquifers in the field to assist numerical modeling

The main equipment used to characterize the physical and geochemical properties of aquifers is a Geotech 605 drilling and sounding rig. Data collected with this equipment enable researchers to model flows and contaminant transport within aquifers. Researchers are also able to evaluate aquifer sensitivity to contamination and determine the most appropriate protection and exploitation strategies for sustainable management of the groundwater resource.

GEORIG 605 in the field

This crawler-mounted rig can simultaneously record several data parameters, enabling the identification of materials and determination of their mechanical and electrical responses and porosity. It can be used for soil or groundwater sampling, eliminating the need for permanent observation wells. The system can also be used to install observation wells by penetration (without drilling). One of the spindles can be used to make soundings by cone penetration (CPT) up to 30 m deep in loose sediments, and the other is equipped with a pneumatic drill to make soundings by rotary percussion up to 50 m deep in rocks and in sediments.

CONTACT:
Dr. **René Lefebvre**, rene.lefebvre@ete.inrs.ca

Characterization of rocks

Automated system for simultaneous measurements of several properties on diamond drill cores – An innovation for mineral exploration

The system is installed in a mobile trailer. Cores placed on a conveyer successively pass through the following sensors that measure the main physical, mineralogical, and chemical properties of the rock:

- High resolution camera
- Gamma densimeter
- Laser (to measure thickness)
- Infrared and visible spectrometer
- Magnetic susceptibility meter
- X-ray fluorescence spectrometer (XRF)
- Electrical conductivity meter

Several portable instruments are also available to measure the physical properties of rocks in the field (magnetic susceptibility, density, electrical conductivity, gamma radiation).

Automated system for characterization of rocks

Measurements of rocks' physical properties can be useful for planning and interpreting geophysical surveys. Geochemical measurements using high-resolution XRF can be used to locate cryptic geological contacts and to quantify hydrothermal alteration, among other tasks. Identification of mineral alteration can be done using infrared and visible spectrometry.

Multivariate statistical analysis of collected data can help to better identify the different geological units. The ultimate objective of this new system is to obtain as much information as possible from drill cores directly on the extraction site.

CONTACT:
Dr. **Pierre-Simon Ross**, pierre-simon.ross@ete.inrs.ca

Publications

INRS-Eau, 30 ans d'histoire

This book about the 30-year history of hydrology research at the INRS was published this year.

Journal of Water Science

www.rse.inrs.ca

An international electronic journal co-edited with the Groupement d'intérêt scientifique des sciences de l'eau (France).

Scientific publications

The annual listing of the publications and communications of the Centre's researchers is available online:
www.ete.inrs.ca/ete/publications

Most of the Centre's research reports and graduate theses are available online:
www.ete.inrs.ca/ete/publications/rapports
www.ete.inrs.ca/ete/publications/theses-memoires

Capsules INRSciences

www.ete.inrs.ca/ete/publications#Capsules INRSciences

Information bulletins highlighting in easily understood language the research carried out by students from the Centre.

Meetings and seminars

Seminar program

The Centre holds scientific seminars related to its various research fields throughout the year.

Meetings and workshops

June 9-12, 2009: *62nd Canadian Water Resources Association National Conference* (CWRA/ACRH 2009) organized in Quebec City by Professor André Saint-Hilaire.

January 28, 2010: Open House at the INRS

April 22, 2010: 2nd meeting of the Research Chair on the Geological Sequestration of CO_2 entitled "CCS in Eastern Canada" (chaireco2.ete.inrs.ca/?q=en/colloque_2010_eng)

Research excellence

Several members of the Centre received awards this year for the excellence of their research or the quality of their scientific communications. Two professors have seen their research work recognized: Peter G.C. Campbell received a doctorate *honoris causa* from the University of Bordeaux, and the Grand Prize for University Research from the American Academy of Environmental Engineers was awarded to Rajeshwar Dayal Tyagi.

Among the Centre's PhD students, Valérie Ouellet (André Saint-Hilaire's team) was named Personality par excellence at the Forces AVENIR Gala and also Personality of the week by the newspaper *La Presse* and Radio-Canada. Michel Lavoie (Claude Fortin's team) received the 2010 PhD award of excellence by the Chapitre Saint-Laurent. In June, Patrick Gagnon (Alain N. Rousseau's team) won the best student poster award at the *62nd Canadian Water Resources Association National Conference*. In November, Lorenzo Perozzi (Erwan Gloaguen's team) and Grégory Dufrechou (Lyal Harris's team) obtained the 1st and 2nd prizes for the best student posters at the Quebec Exploration annual meeting. In February, Neema Prabhakaran Mariyamma (R.D. Tyagi's team) won the best student presentation at the *45th Central Canadian Symposium on Water Quality Research* awarded by the Canadian Association on Water Quality. Several distinctions were received during conferences held in May. Kristin Mueller (P.G.C. Campbell's team) won the best poster award at the *International Training Workshop on Organic Matter Characterization Using Spectroscopic Techniques*.

Danaé Pitre, a Master's student in Claude Fortin's team, received the 2nd prize for best student presentation at the 14th meeting of the Chapitre Saint-Laurent. Finally, Tae Sam Lee, a postdoctoral fellow in Taha B.M.J. Ouarda's team, won the best article award for a presentation at the *Korea Water Resources Association Conference*.

Public outreach

Researchers at the Centre regularly give interviews and contribute to articles in the media (newspapers, radio, television, Internet) within their specialty field.

Volcanologist Pierre-Simon Ross was particularly in demand in April when the volcano Eyjafjöll erupted in Iceland. He gave many interviews for the radio and web sites. Television reports highlighted the work of some of the Centre's research teams. *La Semaine verte* broadcast a report on Carole-Anne Gillis's Master's work (supervised by Normand E. Bergeron) on an invasive alga. Alain Mailhot was interviewed at the *Code Chastenay* about rainwater management. This same television program presented Elsa Goerig's Master's project (also supervised by N.E. Bergeron) on fish passage success through road culverts.

The newspaper *Le Soleil* publishes in December the 10 scientific findings of the year. Pierre Francus was in the spotlight again this year for his contribution to a vast study on Arctic temperatures over the last 2000 years that was published in *Science*. Finally, the magazine *Découvrir* of the Association francophone pour le savoir (ACFAS) published a short article on Satinder Kaur Brar's work on bisphenol A in municipal wastewater.

Training of highly qualified personnel

Six graduate programs are offered at the Centre Eau Terre Environnement. The inter-university Master's and PhD programs in earth sciences are operated in collaboration with the Geology and Geological Engineering Department of the Université Laval. The students are registered in the institution of their supervisor but are trained by both institutions.

Study programs

www.ete.inrs.ca/ete/etudier/programmes

Master's degrees

- Master's in Water Sciences
- Professional Master's in Water Sciences
- Master's in Earth Sciences
- Master's in Earth Sciences – Environmental Technologies

PhD degrees

- PhD in Water Sciences
- PhD in Earth Sciences

Lennie Boutet, Karita Negandhi and Frederick Bilodeau in a helicopter during fieldwork on Bylot Island, Nunavut

Internships and fellowships

The Centre Eau Terre Environnement welcomes postdoctoral fellows in its research groups. INRS postdoctoral scholarships are available. The Centre also offers undergraduate summer internships, an excellent opportunity for students to gain research experience in a highly stimulating scientific environment.

INRS postdoctoral fellowships:

www.inrs.ca/emplois-et-stages/stages#Stages postdoctoraux

The Centre's summer internships:

www.ete.inrs.ca/ete/emplois-et-stages/stages#Stages d'été

Research and teaching

Research teams

Jean-Christian Auclair (P) Limnology

Yves Bégin (P) Dendroecology
- Joëlle Marion (O)
- Antoine Nicault (As)
- Mathilde Renaud (At)
- Jean-Christophe Aznar (Postdoc)
- Stéphanie Wicha (Postdoc)
- Cristian Alvarez (MSc)
- Philippe Boulanger (MSc)
- Thibault Labarre (MSc)

Mario Bergeron (P) Hydrometallurgy
- Marie Létourneau (T)
- Alain Langlais (O and PhD)

Normand E. Bergeron (P) Hydrology – Fluvial geomorphology
- Francis Bérubé (T)
- Marc-André Pouliot (At)
- *Maxime Rousseau (At)*
- Jean-Baptiste Torterotot (At and *I*)
- Stephen Dugdale (PhD)
- Elsa Goerig (PhD)
- Patricia Johnston (PhD)
- Jean-Nicolas Bujold (MSc)
- Joanie Côté (MSc)
- *Jérôme Dubé (MSc)*
- Carol-Anne Gillis (MSc)
- Maxime Grenier (MSc)
- *Véronique Tremblay (MSc)*
- *Maxime Rousseau (I)*
- *André Boivin (Field Assistant)*

Monique Bernier (P) Hydrology – Remote sensing
- Yves Gauthier (O)
- Jalal Khaldoune (As)
- Clément Clerc (At)
- *Jean-Thomas Denault (At)*
- Jimmy Poulin (At)
- *Md. Shah Alamgir (PhD)*
- Maria Dissanska (PhD)
- Rebecca Filion (PhD)
- Kim Huong Hoang (PhD)
- Parvin Kalantari (PhD)
- Stéphane Mermoz (PhD)
- Thomas Bergeron (MSc)
- Stéphanie Bleau (MSc)
- Yannick Duguay (MSc)
- Charles Gignac (MSc)
- Karine Labrecque (MSc)
- Audrey Lessard-Fontaine (MSc)
- *Thomas Bergeron (I)*
- *Gérémy Combret (I)*
- *Stéphane De Munck (I)*
- *Florian Lafage (I)*
- *Inga May (I)*
- *Charles Rioux-Boucher (I)*
- *Julien Saint-Laurent (I)*
- *Marion Tanguy (I)*

Jean-François Blais (P) Decontamination and reclamation
- Myriam Chartier (O)
- Lucie Coudert (PhD)
- Samuel De la Rochebrochard (PhD)
- *Amélie Janin (PhD)*
- Dikenane Kombila (PhD)
- Stéphanie Lafond (PhD)
- Nicolas Reynier (PhD)
- Pascal Castellazzi (MSc)
- Marie-Christine Simard (MSc)
- *Véronique Turcotte (MSc)*
- *Pierre Bausch (I)*
- *Jean-Luc Bisson (I)*
- *Pauline Riche (I)*

Satinder Kaur Brar (P) Decontamination – Biological detoxification
- Ajila Chandran (Postdoc)
- Gurpreet Singh Dhillon (PhD)
- Fatma Gassara (PhD)
- Dipti Mohapatra (PhD)

Bernard Bobée (Emeritous P) Statistical hydrology
- Ouejdene Samoud (I)

Peter G.C. Campbell (P) Aquatic ecotoxicology
- Isabelle Papineau (At)
- *Séverine Le Faucheur (Postdoc)*
- Fabien Pierron (Postdoc)
- *Sophie Cooper (PhD)*
- Kristin Mueller (PhD)

Fateh Chebana (P) Hydrological modeling

Abbreviations

P: Professor-Researcher
T: Research Technician
O: Research Officer
As: Research Associate
At: Research Assistant
Posdoc: Postdoctoral Fellow
PhD: PhD Student
MSc: MSc Student
I: Intern

In Italics: Have graduated or left during the year

Karem Chokmani (P) Hydrology - Remote sensing
- Anas El Alem (PhD)
- Noumonvi Yawu Sena (PhD)
- Yann Dribault (MSc)
- Simon Perreault (MSc)
- *Julien Gambelli (I)*
- *Fabien Gautreault (I)*
- *Jennifer Noël (I)*
- *Sophie Roberge (I)*
- *Maxime Thuillier (I)*
- *Magali Wirtensohn (I)*

Daniel Cluis (Honorary P) Agricultural pollution
- *Julie Corriveau (PhD)*
- *Mathieu Quenum (PhD)*

Patrice Couture (P) Aquatic ecotoxicology
- *Dominique Lapointe (As and PhD)*
- Michel Amery Defo (PhD)
- *Charles Gauthier (PhD)*
- Julie Grasset (PhD)
- Audrey Moffett (MSc)
- *Maxime Bélanger (I)*

Paul Drevnick (P) Contaminant biogeochemistry

Patrick Drogui (P) Decontamination – Electrotechnologies
- *Nam Tran (At)*
- Mandé Léa Rosine Guitaya (PhD)
- Brahima Seyhi (PhD)
- François Zaviska (PhD)
- *Rimeh Daghrir (MSc)*
- *Charlotte Leyre (I)*
- *Jean de dieu Hermann Zongo (I)*

Sophie Duchesne (P) Urban hydrology
- Nabila Bouzida (At)
- Babacar Toumbou (Postdoc)
- Thai Nam Pham (PhD)
- Lise Audet (MSc)
- Jihène Zaiem (MSc)
- *Ariane Pinsonnault (I)*
- *Déborah Souriau (I)*
- *Amélie Thériault (I)*
- *Nicolas Trottier (I)*

Anne-Catherine Favre (P) Statistical hydrology
- *Guillaume Évin (As)*
- *Mériem Saïd (As)*
- *Karine Dion (At)*
- Nguyen Bao Trinh (PhD)
- Thomas-Charles Fortier-Filion (MSc)
- *Jonathan Jalbert (MSc)*

Claude Fortin (P) Aquatic ecotoxicology
- Gabrielle Roy (At and *MSc*)
- Isabelle Lavoie (Postdoc)
- Rachel Olette-Dodson (Postdoc)
- Jonathan Bernier (PhD)
- Anne Crémazy (PhD)
- Michel Lavoie (PhD)
- Danaé Pitre (MSc)
- Marc-André Robin (MSc)
- *Aurélie Mabilat (I)*

Pierre Francus (P) Limnogeology
- Arnaud De Coninck (At)
- David Fortin (Postdoc)
- Frédéric Bouchard (PhD)
- Nicoleta Ciobanas (PhD)
- Stéphanie Cuven (PhD)
- Guillaume Jouve (PhD)
- Vicky Tremblay (PhD)
- François Lapointe (MSc and *I*)

Bernard Giroux (P) Applied geophysics

Erwan Gloaguen (P) Applied geophysics
- Camille Dubreuil-Boisclair (PhD)
- Patrick Simard (PhD)
- Christine Bélanger (MSc)
- Lorenzo Perozzi (MSc)

Charles Gobeil (P) Aquatic geochemistry and contamination
- Sandra Jobidon (T)
- *Zouzou Kuzyk (Postdoc)*
- Raoul-Marie Couture (PhD)
- Stéphane Feyte (PhD)
- *Marie-Ève Randlett (MSc)*

Yves Gratton (P) Physical oceanography
- Dominique Boisvert (At)
- Marie-Emmanuelle Rail (At)
- *Claude Bélanger (Postdoc)*
- Alexandre Forest (Postdoc)
- *Dany Dumont (PhD)*
- Somayeh Nahavandian Esfahani (PhD)
- *Romain Lanos (PhD)*
- Caroline Sévigny (PhD)
- Jessy Barrette (MSc and *I*)
- Charles Brouard (MSc)
- *Antoine Roy-Gobeil (I)*

Landis Hare (P) Aquatic ecotoxicology
- Isabelle Proulx (PhD)
- Karine Bertrand (MSc)
- Julien Lacharité (MSc)
- Dominic Ponton (MSc)
- Maikel Rosabal Rodriguez (MSc)

Abbreviations

P: Professor-Researcher
T: Research Technician
O: Research Officer
As: Research Associate
At: Research Assistant
Posdoc: Postdoctoral Fellow
PhD: PhD Student
MSc: MSc Student
I: Intern

In italics: Have graduated or left during the year

Lyal Harris (P) Structural geology
Elena Konstantinovskaya (As)
Vladimir Antonoff (PhD)
Gregory Dufrechou (PhD)
Camille Armengaud (MSc)

Pierre Lafrance (P) Contaminant biogeochemistry

Isabelle Larocque (P) Paleoclimatology

Isabelle Laurion (P) Limnology
Benoit Ginoux (At)
Paul-Georges Rossi (Postdoc)
Karita Negandhi (PhD)
Christiane Dupont (MSc)
Annabelle Waren (MSc)
Véronique Gélinas (I)
Joanna Kristiina Kuha (I)
Toni Roiha (I)

Michel Leclerc (Honorary P) Ecohydraulics
Paul Boudreau (O)
Pierre-Luc Fortin (MSc)

René Lefebvre (P) Hydrogeology
Jean-Marc Ballard (O)
Harold Vigneault (O)
Belkacem Lahmira (As and *PhD*)
Châtelaine Beaudry (At)
Marc-André Carrier (At)
Rachel Thériault (At)
Pierrick Chasseriau (Postdoc)
Daniel Paradis (PhD)
Laurie Tremblay (PhD)
Patrick Brunet (MSc)
Sara Kazza (I)
Dave Martin (I)
Claudine Nackers (I)
PL Nadège Ouédraogo (I)

Bernard F. Long (P) Sedimentology
Louis-Frédéric Daigle (T)
Régis Xhardé (As)
Mathieu Des Roches (At)
Éric Morissette (At)
Antoine Collin (PhD)
Stéphane Montreuil (PhD)
François Aucoin (MSc)
Valérie Robitaille (MSc)

Alain Mailhot (P) Urban hydrology
Samuel Bolduc (At and *MSc*)
Guillaume Talbot (At)
Brielly Edouard Arnaud Guede (PhD)
Vanessa Montpellier (PhD)
Simon Lachance-Cloutier (MSc and *I*)
Audrey Poulin (I)
Sébastien Raymond (I)
Léonie Sévigny-Côté (I)

Michel Malo (P) Structural geology
Karine Bédard (O)
Jean-Philibert Moutenet (O)
Harold Vigneault (O)
Elena Konstantinovskaya (As)
Gabriel Huot-Vézina (At)
Maxime Claprood (Postdoc)
Franck Diedro (Postdoc)
Gaëlle Grundman (PhD)
Adeline Parent (PhD)
Marie-Claude Brunet-Ladrie (I)
Linda Aubert (Secretary)

Richard Martel (P) Hydrogeology
Clarisse Deschênes-Rancourt (T)
Richard Lévesque (T)
Sébastien Côté (O)
Luc Trépanier (O)
Uta Gabriel (As)
Vincent Boulianne (At)
Géraldine Cosset (At)
Nicolas Francoeur-Leblond (At)
Félix Gravel-Gaumond (At)
Sébastien Lange (Postdoc)
Geneviève Bordeleau (PhD)
Angus Calderhead (PhD)
Mathieu Laporte-Saumure (PhD)
Thomas Robert (PhD)
Aurélie Bellavance-Godin (MSc)
Martin Blouin (MSc)
Guillaume Comeau (MSc)
Jean-Philippe Drolet (MSc)
Marie-Claude Lapointe (MSc)
Marie-Catherine Poulin-Talbot (MSc)
Véronyque Blanchet (I)
Rania Bouziri (I)
Samuel Roy (I)
Michaël Vachon (I)
Véronika Varfalvy (I)
Linda Aubert (Secretary)

Abbreviations

P: Professor-Researcher
T: Research Technician
O: Research Officer
As: Research Associate
At: Research Assistant
Posdoc: Postdoctoral Fellow
PhD: PhD Student
MSc: MSc Student
I: Intern

In Italics: Have graduated or left during the year

Guy Mercier (P) Decontamination and reclamation
- Lan Huong Tran (As)
- Romain Barbaroux (PhD)
- Sara Bisone (PhD)
- Dileep Palakkeel Veetil (PhD)
- *Élaine Boutin (MSc)*
- Charles-Edouard Nanci (MSc)
- Guillaume Nielsen (MSc)
- Louis-César Pasquier (MSc)
- Vincent Taillard (MSc)
- *Nam Tran (MSc)*
- *Vincent-T Boucher St-Amour (I)*
- *Laure Detolsan (I)*
- *Yannis Ferro (I)*
- *Fabien Jeuland (I)*
- *Michel Plourde (I)*

Taha B.M.J. Ouarda (P) Hydrometeorological modeling
- *Fateh Chebana (As)*
- Christian Charron (At)
- Barbara Martel (At)
- Étienne Boucher (Postdoc)
- Dominique Fasbender (Postdoc)
- Tae Sam Lee (Postdoc)
- Lampouguin Bayentin (PhD)
- *Claudie Beaulieu (PhD)*
- Mohamed Aymen Ben Aissia (PhD and *MSc*)
- Bahaa Khalil (PhD)
- Reza Modarres (PhD)
- Mohamed Ali Ben Alaya (MSc)
- Chantal Caouette (MSc)
- Jean-Xavier Giroux (MSc)
- Dorra Hammami (MSc)
- Iris Maria Klein (MSc)
- *Barbara Martel (MSc)*
- *Brahim Brahim (I)*
- *Thuy Chinh Duong (I)*
- *Pierre-Louis Gagnon (I)*
- *Ibrahim Mhadjou (I)*

Claudio Paniconi (P) Hydrogeological modeling
- Cintia Racine (O)
- Asma Chemingui (PhD)
- Mauro Sulis (PhD)

Marc Richer-Laflèche (P) Trace elements geochemistry
- François Pelletier (At)
- *Maxime Aubert (PhD)*
- Yves Caron (MSc)
- Hilda Paucar Munoz (MSc)
- *Nicolas Tremblay (I)*
- *Yves Asselin (Field Assistant)*
- *Jean-François Boily (Field Assistant)*
- *André Castonguay (Field Assistant)*
- *Édith Chouinard (Field Assistant)*
- *Patrick Lachance (Field Assistant)*
- *Kevin Picard (Field Assistant)*
- *Sylvain Poirier (Field Assistant)*

Pierre-Simon Ross (P) Volcanology and economical geology
- *Marlène Villemure (At)*
- Julie Anaïs Debreil (PhD)
- Séverine Delpit (PhD)
- Russel Rogers (MSc)
- *Charlène Gagnon (I)*
- *Mathieu Rossignol (I)*

Alain N. Rousseau (P) Hydrology – Modeling and management
- Alain Royer (T)
- Sébastien Tremblay (T)
- Stéphane Savary (O)
- *Sylvain Jutras (As)*
- *Fanny Quévy (At)*
- *Médard Bouda (Postdoc)*
- Sylvio José Gumiere (Postdoc)
- Gwenael Carrer (PhD)
- Patrick Gagnon (PhD)
- Martine Grenier (PhD)
- Grégor Levrel (PhD)
- Muma Mushombe (PhD)
- *Clément Clerc (MSc)*
- *Brigitte Laberge (MSc)*
- Philippe Noël (MSc)
- Rodrigo Passos (MSc)
- *Élie Bertret (I)*
- *Lucie Cappoen (I)*
- *France-Line Dionne (I)*
- *Kévin Pérard (I)*

André Saint-Hilaire (P) Statistical hydrology – Aquatic habitats
- Anik Daigle (As)
- *Éric Christensen (At)*
- *Martin Matteau (At)*
- *Carol Rendell (At)*
- Dae Il Jeong (Postdoc)
- Julien Mocq (PhD)
- Valérie Ouellet (PhD)
- Simon Tardif (PhD)
- Mohammed Aziz Es Salhi (MSc)
- *Nicolas Guillemette (MSc)*
- Hélène Higgins (MSc)
- Sandra Proulx-McInnis (MSc)
- *Dan Beveridge (I)*
- *Dominic Roussel (I)*
- *Olivier Roy (I)*

Abbreviations

P: Professor-Researcher
T: Research Technician
O: Research Officer
As: Research Associate
At: Research Assistant
Posdoc: Postdoctoral Fellow
PhD: PhD Student
MSc: MSc Student
I: Intern

In Italics: Have graduated or left during the year

Yves Secretan (P) Hydroinformatics
Muluneh Admass Mekonnen (Postdoc)
Pascale Matte (PhD)
Lucie Degousée (I)
Ludovic Gardré (I)
Dikra Khedhaouiria (I)
Pascale Dubé (Liaison Officer)

Normand Tassé (P) Geochemistry
Rajeshwar Dayal Tyagi (P) Decontamination – Waste bioconversion
Balasubramanian Sellamuthu (As and PhD)
Dang Khanh Vu (As and PhD)
Song Yan (As)
François Chabot (At)
Archana Kumani (Postdoc)
Pappy John Rojan (Postdoc)
Kokou Adjalle (PhD)
Jyothi Bezawada (PhD)
Indrani Bhattacharya (PhD)
Jean-Philippe Chenel (PhD)
Zied Djedidi (PhD)
Mathieu Drouin (PhD)
Jean-Robert Gnepe (PhD)
Amine Mahmoudi (PhD)
Josée-Anne Majeau (PhD)
Jia Miao (PhD)
Tanaji More (PhD)
Ha Pham Thi Thanh (PhD)
Sridhar Pili (PhD)
Neema Prabhakaran Mariyamma (PhD)
Tarek Rouissi (PhD)
Jay Shankar Singh Yadav (PhD)
Xiao Lei Zhang (PhD)
Najib Mhamdi (MSc)
Manon Bruyant (I)
Gabriel Cotte (I)
Vanessa Estime (I)
Mélanie Louro (I)
Morgane Mandaud (I)
Gauthier Menassol (I)
Bruno Oliva Oishi (I)
Charlène Orliac (I)
Mickaël Ros (I)
Amina Sghairi (I)

Jean-Pierre Villeneuve (P) Hydrology – Integrated management
Alain Garon (T)
Babacar Toumbou (Postdoc)
Hong Trang Nguyen (PhD)
Phu Duc Nguyen (PhD)
Xuan Tuan Nguyen (PhD)
Thi Thu Ha Pham (PhD)
Richard Turcotte (PhD)
Amélie Gauthier-Duchesne (I)
Audrey Lucchesi-Lavoie (I)
Diane Dawson (Secretary)
Julie Fortin (*Secretary*)
Diane Tremblay (Secretary)

Other students

PhS students supervised by associate professors

Anne-Laure Bonnet (Louise Corriveau)
Lise Lamarche (Michel Parent)
François Leclerc (Jean H. Bédard)
Jean-François Montreuil (Louise Corriveau)
Jean-François Ravenelle (Benoît Dubé)
Kenneth Williamson (Benoît Dubé)

Master's students supervised by associate professors

Catherine Guay (Miroslav B. Nastev)
Abhidheya Holfeld (Patrick Mercier-Langevin)
Rachel Thériault (Martine M. Savard)

In the Professional Master's Program

Sanaa Benamar
Daniel Bessette
Marie-Andrée Boisvert
Mélissa Châtelain
Jonathan Daigle
Julien Gaubert
Martin Genest
Matthew Landry
Charles-Olivier Laporte
Marianne Métivier
Maggy P. Rousseau
Dominic Roussel
Martin Tremblay

Other professors

Emeritous

Georges Drapeau
Michel Slivitzky

Honorary

Aïcha Achab
Jean-Pierre Fortin
Sinh Lequoc
Guy Morin
Jean-Louis Sasseville
Alain Soucy
André Tessier

Abbreviations

P: Professor-Researcher
T: Research Technician
O: Research Officer
As: Research Associate
At: Research Assistant
Posdoc: Postdoctoral Fellow
PhD: PhD Student
MSc: MSc Student
I: Intern

In Italics: Have graduated or left during the year

Associate

Jason Ahad, GSC-Quebec
Guy Ampleman, DRDC-Valcartier
Marc Barbet, Hydro-Québec
Jean H. Bédard, GSC-Quebec
Christian Bégin, GSC-Quebec
Sébastien Castonguay, GSC-Quebec
Louise Corriveau, GSC-Quebec
Benoît Dubé, GSC-Quebec
Mathieu J. Duchesne, GSC-Quebec
Donna Kirkwood, GSC-Quebec
Denis Lavoie, GSC-Quebec
Patrick Mercier-Langevin, GSC-Quebec
Yves Michaud, GSC-Quebec
Léopold Nadeau, GSC-Quebec
Miroslav B. Nastev, GSC-Quebec
Michel A. Parent, GSC-Quebec
Luc Perreault, Hydro-Québec
Didier Perret, GSC-Quebec
Nicolas Pinet, GSC-Quebec
Christine Rivard, GSC-Quebec
Alfonso Rivera, GSC-Quebec
Martine M. Savard, GSC-Quebec
Sonia Thiboutot, DRDC-Valcartier

Invited

Marc Amyot, Université de Montréal

Khalidou M. Bâ, Universidad Autónoma del Estado de México (Mexico)

András Bárdossy, Institut für Wasserbau (Germany)

Ridah Ben Cheikh, École nationale d'ingénieurs de Tunis (Tunisia)

Hamel Benmoussa, Centre de recherche industrielle du Québec

Louis Bernatchez, Université Laval

Thomas Buffin-Bélanger, UQAR

Daniel Caissie, Fisheries and Oceans Canada

Stéphane Campeau, UQTR

Alin A. Cârsteanu, Instituto Politécnico Nacional (Mexico)

Bernard Chocat, Institut national des sciences appliquées de Lyon (France)

Daniel Cossa, Institut français de recherche pour l'exploitation de la mer (France)

Simon Charles Courtenay, Fisheries and Oceans Canada

Jean-Pierre Dedieu, LARHRA – CNRS (France)

Carlos Díaz Delgado, Centro Interamericano de Recursos del Agua (Mexico)

Salaheddine El Adlouni, Institut national de statistique et d'économie appliquée (Morocco)

Philippe Gachon, Environment Canada

Jaime M. Gárfias Soliz, Centro Interamericano de Recursos del Agua (Mexico)

Christian Genest, Université Laval

Jean-Louis Goergen, Institut national polytechnique de Lorraine (France)

Pierre-Louis Gosselin, Institut national de la santé publique du Québec

Bernard Hétu, UQAR

William J. Kamphuis, Queen's University

Scott Lamoureux, Queen's University

Corrine Leyval, LIMOS – CNRS (France)

Robie W. Macdonald, Fisheries and Oceans Canada

Jean-Louis Morel, Institut national polytechnique de Lorraine (France)

Mir Abolfazo Mostafovi, Université Laval

Emmanuel Naffrechoux, Université de Savoie (France)

Michel Nolin, Agriculture and Agri-Food Canada

Reinhard Pienitz, Université Laval

André P. Plamondon, Université Laval

Éric Pottier, Institut d'électronique et de télécommunications de Rennes (France)

John F.V. Riva, retired, Université Laval

René Roy, Institut de recherche d'Hydro-Québec

Éric Sauquet, CEMAGREF (France)

Ousmane Seidou, University of Ottawa

Marie-Odile Simonnot, Institut national polytechnique de Lorraine (France)

Minh Y Tran, Vietnam Academy of Science and Technology (Vietnam)

Bruno Tremblay, McGill University

Gozo Tsujimoto, Kobe City College of Technology (Japan)

José R. Valéro, retired, Canadian Forest Service

Éric van Bochove, Agriculture and Agri-Food Canada

Jaume M. Verges, Institut de Ciències de la Terra Jaume Almera (Spain)

Alan L. Watchman, Australian National University (Australia)

Kevin J. Wilkinson, Université de Montréal

Fumihiko Yamada, Kumamoto University (Japan)

Xuebin Zhang, Meteorological Service of Canada

Fatiha Zidane, Université Hassan II (Morocco)

Other researchers

Associate

Jean Morin, Environment Canada

Invited

Todd E. Arbetter, National Ice Center (USA)

Philippe Archambault, Institut des sciences de la mer de Rimouski

Simon Barnabé, EcoNovo Experts-conseils

Françoise Behar, Institut français du pétrole (France)

Claudia Blais, Institut national de la santé publique du Québec

Amiel Boullement, Rio Tinto Alcan

Guy Caniaux, Centre national de recherches météorologiques (France)

Daniel Caya, Ouranos Consortium

Martin Chantigny, Agriculture and Agri-Food Canada

Marie Clément, Fisheries and Oceans Canada

Yves Couillard, Environment Canada

Bernard Doyon, Collège F.X. Garneau

Donald Forbes, Geological Survey of Canada – Atlantic

Vincent Fortin, Institut de recherche d'Hydro-Québec

Peter S. Galbraith, Fisheries and Oceans Canada

Feten Jarraya Horriche, Centre de recherches et des technologies des eaux (Tunisia)

Yvon Maranda, Ministère du Développement durable, de l'Environnement et des Parcs du Québec

Stéphane Masson, Parc Aquarium du Québec

Marc Mingelbier, Ministère des Ressources naturelles et de la Faune du Québec

Louis Prieur, Observatoire océanologique de Villefranche-sur-Mer (France)

Mathieu Ribatet, École polytechnique fédérale de Lausanne (Switzerland)

Philippe Rochette, Agriculture and Agri-Food Canada

Muriel Thibaut, Institut français du pétrole (France)

Some collaborators

Yves Bégin
- Dominique Arseneault, UQAR
- Frank Berninger, UQAM
- Jean-Jacques Boreux, Université de Liège (Belgium)
- Gilles Brosseau, Hydro-Québec
- Daniel Caya, Ouranos Consortium
- Jean-Luc DesGranges, Environment Canada
- Joël Guiot, CEREGE (France)
- Luc Perreault, Institut de recherche d'Hydro-Québec
- René Roy, Institut de recherche d'Hydro-Québec

Normand E. Bergeron
- Julian Dodson, Université Laval
- André Roy, Université de Montréal

Monique Bernier
- Michel Allard, Université Laval
- Michael Barret, Kativik Regional Government
- Danielle De Sève, Institut de recherche d'Hydro-Québec
- Paul Dockrill, Wind Energy Institute of Canada
- Stéphane Gagnon, Environment Canada
- Anick Guimond, Ministère des Transports du Québec
- Gaëtan Lafrance, INRS – Centre Énergie Matériaux Télécommunications
- Esther Lévesque, UQTR
- Ralf Ludwig, Ludwig-Maximilians-Universität (Germany)
- Serge Payette, Université Laval
- Jean-Pierre Savard, Ouranos Consortium
- Éric van Bochove, Agriculture and Agri-Food Canada

Jean-François Blais
- Paul Cooper, University of Toronto
- Louis Gastonguay, Hydro-Québec
- Paul Morris, FPInnovations

Satinder Kaur Brar
- Stéphane Godbout, Institut de recherche et de développement en agroenvironnement (IRDA)
- José R. Valéro, retired, Canadian Forest Service
- Mausam Verma, IRDA

Peter G.C. Campbell
- Yves Couillard, Environment Canada
- Kevin J. Wilkinson, Université de Montréal
- William Zerges, Concordia University

Karem Chokmani
- Danielle De Sève, Institut de recherche d'Hydro-Québec

Patrice Couture
- Louis Bernatchez, Université Laval
- Gregory Pyle, Lakehead University

Patrick Drogui
- Raja Ben Amar, Faculté des Sciences de Sfax (Tunisia)
- Marc Hera, École polytechnique universitaire de Montpellier (France)
- Abdelhadi Lhassani, Faculté des Sciences et techniques de Fès (Morocco)

Sophie Duchesne
- Marjorie Ramirez, Ville de Québec

Claude Fortin
- Amiel Boullemant, Rio Tinto Alcan
- Bermans Drouin, Réserve faunique des Chic-Chocs
- Langis Fournier, Ministère des Ressources naturelles et de la Faune du Québec (MRNF)
- Luc Gagnon, Groupe GDS
- René Lafond, MRNF
- Feiyue Wang, University of Manitoba

Pierre Francus
- Daniel Ariztegui, Université de Genève (Switzerland)
- Raymond S. Bradley, University of Massachusetts (USA)
- Laurie Brown, University of Massachusetts (USA)
- Scott Lamoureux, Queen's University
- Nora I. Maidana, Universidad de Buenos Aires (Argentina)
- Bernd Milkereit, University of Toronto
- Christian Ohlendorf, Universität Bremen (Germany)
- Reinhard Pienitz, Université Laval
- Doug R. Schmitt, University of Alberta
- Stefan Wastegard, Stockholm University (Sweden)
- Bernd Zolitschka, Universität Bremen (Germany)

Erwan Gloaguen
- Gilles Bellefleur, Geological Survey of Canada – Ottawa
- Alexandre Boucher, Stanford University (USA)
- André Leite, Vale Inco
- Denis Marcotte, École Polytechnique de Montréal
- Yvan Petit, École de Technologie supérieure
- Stéphane Rondenay, Massachusetts Institute of Technology

Charles Gobeil
- Robie W. Macdonald, Fisheries and Oceans Canada

Yves Gratton
- David Barber, University of Manitoba
- Daniel Bourgault, UQAR
- Louis Fortier, Université Laval
- Peter S. Galbraith, Fisheries and Oceans Canada
- Maurice Levasseur, Université Laval
- Louis Prieur, Observatoire océanologique de Villefranche-sur-Mer (France)
- Yvan Simard, UQAR
- Fiamma Straneo, Woods Hole Oceanographic Institute (USA)
- Bruno Tremblay, McGill University
- Jean-Éric Tremblay, Université Laval

Lyal Harris
- Warren Hawkins, Richmond Minerals
- Patrick Lengyel, Laurentian Goldfields

Isabelle Laurion
- Marc Amyot, Université de Montréal
- Connie Lovejoy, Université Laval
- Alexandre Poulain, University of Ottawa
- Milla Rautio, UQAC
- Warwick F. Vincent, Université Laval

René Lefebvre
- Vincent Cloutier, UQAT
- Réal Daigneault, UQAC
- Marie Larocque, UQAM
- Catherine Laurence-Ouellet, Organisme de bassin versant de la Yamaska
- Aubert Michaud, Institut de recherche et de développement en agroenvironnement
- John Molson, Université Laval
- Roger Morin,US Geological Survey (USA)
- Alain Rouleau, UQAC
- René Therrien, Université Laval

Alain Mailhot
- Diane Chaumont, Ouranos Consortium
- Caroline Larrivée, Ouranos Consortium
- Geneviève Pelletier, Université Laval

Michel Malo
- François Baudin, Université Pierre et Marie Curie (France)
- Georges Beaudoin, Université Laval
- Martin Bêche, Pétrolia
- Françoise Behar, Institut français du pétrole (France)
- Daniel Brisebois, Pétrolia
- Bernard Granger, Pétrolia
- François Lorant, Institut français du pétrole (France)
- Luc Massé, Junex
- Muriel Thibaut, Institut français du pétrole (France)

Richard Martel
- Guy Ampleman, DRDC-Valcartier
- Sylvie Brochu, DRDC-Valcartier
- Nathalie Roy, DRDC-Valcartier
- Sonia Thiboutot, DRDC-Valcartier

Guy Mercier
- Martin Chantigny, Agriculture and Agri-Food Canada
- Sandra Kentish, University of Melbourne (Australia)
- Philippe Rochette, Agriculture and Agri-Food Canada

Taha B.M.J. Ouarda
- Marc Barbet, Hydro-Québec
- Zoubeïda Bargaoui, École nationale d'ingénieurs de Tunis (Tunisia)
- Patrick Bogaert, Université Catholique de Louvain (Belgium)
- Salaheddine El Adlouni, Institut national de statistique et d'économie appliquée (Morocco)
- Philippe Gachon, Environment Canada
- Samir Gharbi, Canadian Coast Guard
- Pierre Gosselin, Institut national de la santé publique du Québec
- Deborah Lee, US Army Corps of Engineers (USA)
- Alain Pietroniro, National Hydrology Research Centre
- Alain Vanasse, Université de Sherbrooke

Claudio Paniconi
- Marie Larocque, UQAM
- Richard Turcotte, Centre d'expertise hydrique du Québec

Marc Richer-LaFlèche
- Richard Lachapelle, Scintrex
- Gary Rice, Geofrontiers

Pierre-Simon Ross
- Michel Allard, Xstrata Zinc
- Tony Brisson, Ressources Cogitore
- Michel Chouteau, École Polytechnique de Montréal
- Michel Dessureault, Xstrata Zinc
- Damien Gaboury, UQAC
- Jean Goutier, Ministère des Ressources naturelles et de la Faune du Québec (MRNF)
- Benoit Lafrance, Ressources Cogitore
- Marc Legault, MRNF
- Vicki McNicoll, Geological Survey of Canada – Ottawa
- Gilles Roy, Xstrata Zinc

Alain N. Rousseau
- Stéphane Campeau , UQTR
- Daniel Caya, Ouranos Consortium
- Jacques Deschênes, Ville de Québec
- Sylvain Jutras, Université Laval
- Yvon Maranda, Ministère du Développement durable, de l'Environnement et des Parcs du Québec
- Richard Turcotte, Centre d'expertise hydrique du Québec
- Wanhong Yang, University of Guelph

André Saint-Hilaire
- Daniel Caissie, Fisheries and Oceans Canada
- Marie Clément, Fisheries and Oceans Canada
- Malcom Conly, Environment Canada
- Simon Courtney, Fisheries and Oceans Canada
- Philippe Gachon, Environment Canada
- Stéphane Gariépy, Agriculture and Agri-Food Canada
- Michel Lapointe, McGill University

Rajeshwar Dayal Tyagi
- Danielle Prévost, Agriculture and Agri-Food Canada
- José R. Valéro, retired, Canadian Forest Service

Services

In italics: Have left during the year

Direction

Yves Bégin (Director)
- Isabelle St-Jacques (Assistant)
- Ariane Leduc (Secretary)
- *Roxane Dubé (Secretary)*

Research liaison

Carole Parent
- Stéphanie Racine

Administration

Nicole Laflamme (Service Head)
- Dominique Cantin
- Diane Lortie
- *Julie Matte*
- Marie-Noëlle Ouellet
- Mylène Paradis
- Manon Poitras
- Guylaine Vallée
- Evelyne Vallières

Building

Serge Marcoux (Service Head)
- Céline Bélanger
- *Jean Breton*
- Sylvain Dufour
- Gilles Guérin
- *Éric Lortie*
- Alain Poirier
- Louise Robitaille
- Luc Rose
- Pierre Tailleur

Computer and telecommunication service

Claude Blanchette (Service Head)
- Claude Champagne
- Martin Gagné
- Luc Jalbert
- Patrick Laforte
- Marc Saint-Pierre

Documentation and information

Jean-Daniel Bourgault (Service Head)
- Pascale Dion
- Sophie Magos
- Chantal Paquin
- Anne Robitaille
- Jean-Michel Thériault

Laboratories

Stéfane Prémont (Service Head)
- Anissa Bensadoune
- *Michelle Bordeleau Geoffroy*
- Jean-François Dutil
- Sébastien Duval
- Pauline Fournier
- Philippe Girard
- Marc Greendale
- Julie Perreault
- Lise Rancourt
- René Rodrigue

Cartography

Marco Boutin

Teaching

Suzanne Dussault
- Johanne Desrosiers

Interns

- *Kim Aubin*
- *Paschale Noël Bégin*
- *Isabelle Durette*
- *Martin Gagnon*
- *Jacques Gauthier Duchesne*

Revenues and expenses of operating fund (x $1000)

For the financial year ending 31 May 2010

Revenues		
Total institutional revenues		9 804
Other revenues		2 631
Research grants		
• NSERC	3 139	
• FQRNT	440	
• Other sources	4 012	
Total grants		7 591
Research contracts		6 256
Total revenues		26 282
Expenses		
Research and teaching		19 820
Support for research and teaching		
• General administrative costs	1 660	
• MAO purchases (furnishings, instruments, and equipment)	13	
• Documentation and editing	422	
• Direction of Centre	349	
• Computer service	211	
• Laboratories	660	
• Land and buildings	1 093	
• Geological Survey of Canada Agreement	281	
• Large-scale laboratories	599	
• Research station	10	
Total support for research and teaching		6 098
Total expenses		25 918
Excess of revenues over expenses*		**364**

*excluding reserve for pay equity

Reserves of the Centre (x $1000)

For the financial year ending 31 May 2010

Operating fund reserve	
Accumulated surplus on 31 May 2005	1 711
Operating surplus on 31 May 2006	540
Revised operating surplus on 31 May 2007	942
Operating surplus on 31 May 2008	448
Operating surplus on 31 May 2009	396
Operating surplus on 31 May 2010	-108
Total surplus	3 929

Capital fund reserve	
Unused balance on 31 May 2005	745
Balance transferred 2005-2006	550
Balance transferred 2006-2007	900
Adjustment 2005-2006	1 442
Unused total balance on 31 May 2006	3 637
Use of funds to finish reimbursing Édifice Québec	-2 853
Unused balance forecasted on 31 May 2007	784
Unused balance on 31 May 2008	131
Unused balance on 31 May 2009	127
Unused balance on 31 May 2010	127

University expenses by function (x $1000)

For the financial year ending 31 May 2010

	Salaries, benefits and scholarships	Field work, travel, supplies and material	Professional, contractual and public services; rent	Total
Research and teaching (operation)	4 987.8	33	952.5	**5 973.3**
Research and teaching (research)	5 312.7	1 441.8	6 092.2	**13 846.7**
General administrative costs	914.4	32.6	712.6	**1 659.6**
MAO purchases (furnishings, instruments, and equipment)	0	0	13.3	**13.3**
Documentation and editing	303.5	1	118	**422.5**
Direction of centre	310	21.9	16.9	**348.8**
Computer service	335.7	0.4	-125.3	**210.8**
Laboratories	515.7	0.7	143.4	**659.8**
Land and buildings	444.6	2.4	1 445.9	**1 892.9**
Geological Survey of Canada Agreement	240.6	12.3	27.7	**280.6**
Large-scale laboratories	30.5	0.9	567.6	**599**
Research station	0	-1.4	11.7	**10.3**
Total	14 395.5	1 545.6	9 976.5	25 917.6

WWW.INRS.CA

INRS
Université d'avant-garde